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AND

PATTERN-MAKER.

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THE FOUNDRY TRADE JOURNAL,
165, Strand, London, W.C.

BRITISH FOUNDRYMEN'S ASSOCIATION.

LIST OF SECRETARIES.

General Secretary: J. E. H. Allbutt, Sheepbridge House, Chesterfield.

Manchester: Edward Oakes, 46, Ashfield Road, Dickenson Road, Rusholme, Manchester.

Birmingham: C. Heggie, 76, Hillaries Road, Erdington, near Birmingham.

Cardiff: R. Griffiths, Messrs. J. Williams & Sons, Ltd., Globe Foundry, Cardiff.

NOTES AND COMMENTS.

The Birmingham Branch of the B.F.A.

If any proof were needed of the definite sphere of usefulness that the branch Associations of the British Foundrymen's Association are filling, it could be found in the remarkable vitality displayed by the Birmingham district. Formed only a year ago, this first offshoot from the parent body has doubled its membership and has gathered round it a group of leaders, able and fluent in debate, and capable of giving real distinction to a discussion on a technical or scientific subject. One has only to attend their monthly meetings at the great Technical School in Suffolk Street to appreciate the service which the Branch must be rendering to the foundry industry of the Midlands, in the way of disseminating information and instruction on every conceivable side of foundry practice. One sees rows of earnest students, some still in their apprenticeship, but the majority men with years of practical experience behind them, all armed with notebook and pencil, making careful record of the speaker's words, and treasuring up for future use the hints and suggestions liberally distributed by men who possess an unrivalled knowledge of the problems to be faced amidst the grime, the noise, and the clamour of the foundry shop. The value of such a work cannot be over-estimated. Here can be obtained instruction not readily accessible to the ordinary foundryman, and the mental stimulus gained by this contact with minds perhaps more experienced in the foundryman's craft than his cannot but be of inestimable value to him, and of far-reaching effect on the industry itself. The human factor is the most important one in the foundry, as in any other workshop, and it is to the intellectual improvement of this factor that this Branch Association addresses itself, and addresses itself with success.

The Formation of the Branch.

The formation of the Branch was due to the initiative of four of its present

principal office-holders — Messrs. R. Buchanan, F. J. Cook, R. Mason, and C. Heggie. Mr. Cook carried on the secretarial work at the commencement. There was at that time a nucleus of some score of members. The opening of the second session a month ago recorded a membership of 100. This is progress of a most satisfactory kind. No little of it is due to Mr. Heggie, who has filled the post of hon. secretary with unflagging zeal. The Council consists of Messrs. Buchanan, F. J. Cook, E. B. Crump, C. Heggie and R. Mason. Mr. Buchanan is also the President, a position he filled last year. Mr. Cook is a Vice-President, and Messrs. Buchanan and Mason are Councillors of the parent Association. There are two other gentlemen to whose kindly interest the Branch has owed a great deal—Professor T. Turner, of the Birmingham University, and Mr. A. H. Hiorns, the Principal of the metallurgical department of the Technical School. Professor Turner took from the very commencement a great interest in the Branch's doings, and has been a ready contributor of papers at its meetings. To Mr. Hiorns the members owe a debt of gratitude for the warm sympathy he has shown in their work. It was to his good offices that they secured the use of one of the lecture theatres at the School, and in every possible way he has done what he could to help the Branch over the initial difficulties connected with its formation. He is a regular attender at its meetings, always ready to preside over the gatherings and to contribute to the discussions.

Its Field of Usefulness.

That there is a wide field of usefulness before this Association is very evident. Although only in its infancy as yet, the Branch has already an excellent record. The papers read before it have been of a high character, and a no less important feature of its programme is the series of visits that are made to important works in the neighbourhood. For the current session, for instance, they include visits to Messrs. Bradley & Sons' Blast Furnaces, Darlaston, and Messrs. A. Hickman, Limited, Bilston. These excursions, it is pleasing to note, are very popular and largely patronised

What the Branch suffers from, and it is a complaint that is echoed in many an older and more pretentious society, is that only a very small proportion of the members can be induced to take part in the discussions. Mr. Mason, in his blunt, good-humoured fashion, said at the last meeting that "they came there, absorbed a good deal of information, but refused to pass it on." That is hardly a generous interpretation to put upon the nervousness of a young foundryman in the presence of professors and practised debaters like Mr. Mason himself is. There is no doubt that this reserve will disappear in time, and from the 100 members of the Branch there will be found a score or more gifted, as the Scotch lady said, "with the gab." In the meantime, it might be of use to follow the policy adopted in some technical societies of allowing questions to be put in writing and handed to the chairman or lecturer. This might lead to the more rapid exchange of ideas and widen the discussion. The Branch has started the session well, both in respect to attendances and the papers read, and the current session promises to be a great advance even on the success attained last year. With the wide district it covers, there is no question of the prosperous future before the Branch.

Criticism in the Foundry.

In no place, perhaps, is the art of criticism practised more than in the foundry. The practice is one common to all departments and to all branches of the trade. It might be to our advantage to give this subject some consideration and try to deduce from our reasoning why criticism is so prevalent in the foundry. One reason, and, perhaps, the chief reason, is owing to the varying nature of the work undertaken by the founder. It is quite common to see work coming into the foundry the like of which has never previously been seen, and possibly may never enter it again, or, if so, years may elapse between the intervals. There are certain features common to all classes of work, but every casting, although it may to all appearance resemble some other piece of work, will have its own particular features requiring special consideration. It is usually in the treatment of these special features that the divergency of opinion exists. Possibly the greatest amount of criticism which takes place in the foundry is in the moulding and pattern departments. Should any difficulty arise in the moulding the blame falls on the pattern-maker, and the pattern-maker in turn criticises the ability of the moulder, and so on.

A Suggestion.

Now why this state of matters should exist we fail to see. We consider it is the duty of the pattern-maker to take his instructions from the moulder, before starting to construct the pattern, as to how the work should be moulded, and the pattern-maker should embody in the pattern the moulder's instructions, so far as they are practicable and in conformity with the design.

If this arrangement was more generally adopted, a better feeling would exist between these departments than that which sometimes is the case, and a great deal of talk would be averted, and better and cheaper work would be the result. In many jobs circumstances enter which compel certain courses to be adopted, and before one can judge with propriety concerning any piece of work, he should be conversant with these circumstances, and also with the difficulties which had to be overcome in bringing the work to a successful issue. The perfect foundryman is unknown, and no one can afford to pose as such.

THE CHARLIER FURNACE.

It is only within the past few years that much advance in brass-foundry methods has been made. An important industry the world over, brass founding for two centuries or more has been practised with little or no improvement in method and without manifestation of desire for a change of conditions in the direction of greater economy in production and the lessening of labour.

The Charlier furnace, which is one of the newer types of melting furnaces burning oil or gas and dispensing with crucibles, is adapted to melting brass, bronze, copper, grey and white iron, wrought iron, steel, aluminium, lead, tin, zinc, manganese, etc. The furnace is, indeed, used satisfactorily in several establishments where German silver and other difficult and expensive alloys are cast. As an emergency furnace in an iron foundry it is a convenient auxiliary, and the furnace is in use for making small steel castings.

THE CHARLIER FURNACE AT THE WORKS OF MESSRS. PINTSCH'S PATENT LIGHTING CO., LTD., LIMEHOUSE.

In brass foundries and metal refineries

the scope of the furnace is large for mixtures, sweepings, turnings, borings and planings, and scrap, the size of the pieces charged being only limited by the diameter of the charging hole. Where very large pieces necessitate breaking it is customary to place them under the furnace and revolve the furnace, so that the heat and flame can play upon the scrap for a few minutes, when a blow or two from a hammer will break it into small pieces of a charging size. Large pieces of rolled sheet and tubing may be passed into the charging hole vertically and allowed to run down as they melt.

When light cheap scrap, or scrap of doubtful quality is run down, any iron or steel contained in it can be seen and skimmed off, insuring good metal for machining.

When large castings are to be poured, a forged yoke may be fitted for connection to the trunnions, and the furnace carried by a crane or overhead travelling hoist to the pouring floor, where a mould may be poured direct from the furnace. During melting, the metal is at all times easily seen.

The furnace consists of a steel casing a delicate mixture may be run almost immediately following a common grade of metal. Small or delicate castings may be poured direct from the furnace in its stationary position when required by a system of tramway laid to the furnace with a turntable or switch at a convenient point for running off the mould carriers.

The furnace consists of a steel casing or shell, lined substantially with firebricks, having a charging opening on the side, and a firing hole at the end forms the combustion and melting chamber. The firing hole is in the centre of the head nearest the charging hole and continues through a trunnion cast on the head. The opposite head is solid, with a solid trunnion squared at the end to receive a hand wheel. The cylinder or chamber is thus enabled to rest upon two cast-iron stands, and is easily revolved by the hand wheel on its longitudinal axis. The hollow trunnion in the firing head allows of easy and free access for the burner, which remains rigid when the cylinder is revolved; and owing to the length of the orifice, there is no possibility of oil leakage. The burner is of a free-burning type. It is fitted to take a 3-in. blast-pipe at its lower end, and oil piping enters at the rear end. Pipe connection to the burner is made from a swing joint at the burner, such swing joint being piped to a similar joint at the floor or base of the furnace. This arrangement allows of instant withdrawal of the interior parts of the burner for cleansing or adjustment. Between these two swing joints a special valve is inserted to control the supply of oil. In the blast pipe, near to the oil valve in the oil pipe, a blast gate is inserted, so that both oil and air supply may be controlled simultaneously. The heads of the furnace are designed to tightly fit into the combustion chamber or cylinder, and are bolted into position in a manner which permits of their being easily withdrawn when it is necessary to reline the furnace.

The oil fuel in most cases is supplied to the burner by a gravity system which consists of an overhead gravity tank with a capacity of 10 to 20 gallons, to which oil is pumped by hand or power from a reservoir tank located conveniently for piping either inside or outside a building, and generally underground. When the gravity tank is placed at a height of 12 ft. or more above the furnace, a head pressure of 5 lbs. to the square inch is obtained, which is ample for the oil feed. The air-blast is provided by an ordinary fan-blower, capable of giving a pressure of at least 8 ozs. to the square inch at its outlet. A No. 4 Sturtevant blower, running at about 2,900 revolutions per minute, or a small rotary pressure blower, which may be run at about 150 revolutions and requires only three-quarters of a horse-power to operate it, can be used. A sheet-iron hood of ample dimensions should be suspended over the furnace to catch the fumes, with a stack running from the hood to the atmosphere, or into a convenient flue.

The furnace most generally used is the No. 2, and the following table covers results ordinarily obtained from this furnace. The other furnaces give the same results proportionate to their capacities:—

600 lbs.	gun metal ...	melted in 1 hr.	
600	„ yellow brass ...	„ „	40 mins.
650	„ red brass ...	„ „	50 „
500	„ semi-steel ...	„ „	2 hrs.
500	„ steel scrap ...	„ „	3 „
500	„ cast iron scrap...	„ „	1 hr. 40 mins.

Turnings and borings require a little longer time than heavier metal. Many foundries are running No. 2 furnaces with an average output of 4,000 lbs. of metal per day per furnace.

Messrs. Bennett & Son, of 42, Trinity Square, Tower Hill, E.C., are the sole agents for this furnace.

BRITISH FOUNDRYMEN'S ASSOCIATION.

Birmingham Branch.

THE Birmingham Branch, to the number of about 40 members, on Saturday, November 9, paid a visit to the Corporation Gas Works, Saltley, this being the first event of the kind for the season. They were courteously received by two of the head officials, and spent the afternoon in visiting the various departments. Special attention was devoted to the machinery, of which some of the most important has been in continuous operation for 30 years, and is still most efficient. Hydraulic apparatus is used for lifting material, and for raising the covers of the large purifiers, steam power being employed for pumps and various miscellaneous machinery, and compressed air for the charging and drawing machines. Extension has been almost constant for a number of years, and the concern is now splendidly equipped for coping with the largest demands. The apparatus for dealing with the by-products is so perfect that waste is practically a thing of the past. The precautions against accident are also very complete. A fine set of machinery is employed for charging the retorts—an operation witnessed by the visitors—as well as for withdrawing the exhausted coke, while labour is minimised by a system of continuous conveyors. The laboratory is most efficient, various dials indicating not only the heat of the various furnaces but the candle-power of the gas. The visitors were greatly interested, and at the close conveyed their thanks to the officials for their courteous assistance.

A MEETING of the Birmingham Branch of the British Foundrymen's Association was held at the Technical School, Suffolk Street, Birmingham, on Saturday, November 23, when a lecture was delivered by Professor T. Turner, of the Birmingham University, on "The Crystallisation of Cast Iron."

Mr. F. J. Cook, Vice-President of the Association, presided over a large attendance.

The PROFESSOR showed that metals generally show a marked tendency to crystallise when solidifying or when heated nearly to their point of fusion. The crystals generally belong to the cubic system, though there are exceptions to this rule. Crystal planes and faces usually form lines of weakness along which fracture can take place, so that however interesting crystals may be to the mineralogist they are to be avoided if of large size, at all events by the metallurgist. The form a crystal takes depends upon the rate of cooling, and also upon the relative freedom of motion in the solidifying mass, so that either perfect crystals, compound crystals, or a cellulous structure filled with microscopic cubic crystals may be produced according to circumstances. This last form is the most common, and is the one usually met with in iron and steel. The question of crystallisation is of very great importance to the ironfounder, as with some kinds of iron, and with angles or sharp alterations of shape, crystals are apt to form and cause weakness in unexpected directions.

The lecture, which was illustrated with a number of lantern-slides showing remarkable photographs of crystal structures, was thoroughly appreciated, and the lecturer was warmly applauded at the close.

The CHAIRMAN said the subject came home to foundrymen, and explained the reason why many things were done by the moulder who did not always know the reason for his action. For example, it was customary to round the corners of square castings, which somehow reduced their liability to fracture.

MR. A. H. HIORNS said the lecture had been extremely lucid, especially in showing evil effects produced by a minute portion of impurity, which acted as nuclei round which the metal crystallised, and so entirely altered the structure of the metal. They knew that the same thing was true of bismuth in copper, and in steel a very minute quantity of phosphorus would make the steel useless for certain purposes. The same remarks would apply to sulphur and manganese, and possibly that explained why so small a quantity of sulphur had such an enormous influence upon the steel, and so it was necessary to limit the quantity to a very minute portion.

MR. WRIGHT, representing the Society of Mechanical Engineers, expressed his thanks to Professor Turner, who had been very kind to that Society, and also to the foundrymen, for the invitation which had enabled them to hear the lecture.

MR. R. MASON said he was almost afraid to mention the old subject of shrink holes in castings, which were a

perpetual puzzle to them, and they had sometimes thought they would like to be inside the casting while cooling was going on to know exactly what was happening. The wonderful pictures shown reminded him of that remarkable group of crystals exhibited at the New Birmingham University. They were beginning to understand how it was that castings broke in certain places, like the cannon which burst at Sebastopol. It was very important for the moulder to understand that the growing crystals indicated lines of weakness. He had found it a good plan to leave a piece of iron sticking up in the mould, and that causing the iron to solidify more quickly prevented the shrink holes.

Mr. Poole said several of them had gathered a few wrinkles from the lecture. One of his own experiences was the production of a casting which had in it a depression three-eighths of an inch deep by 2 in. long. He broke it through and found the texture of it perfect in every way. He would like to know the cause of that. He found also a difficulty in dealing with spindles 4 in. in diameter by 2 ft. long, which did not readily become solid. He would like to know whether any difference in the pouring would get over that difficulty.

Mr. Saddler related his experience with a blow-hole, which appeared in a thick part of the housing, large enough to take in a man's fist, and which seemed to have in the centre a lot of strings of metal almost like icicles.

Mr. Heggie expressed his thanks for the lecture, stating that they could always depend upon Professor Turner, who had been a good friend to the Association.

The Chairman moved a very hearty vote of thanks to the Professor for his lecture, and for the great kindness he had shown, not only to the Birmingham Branch, but to the parent Association, of which he was a life honorary member, rendering most valuable help, especially in connection with the annual Conference.

Mr. Mason seconded, and the resolution was heartily carried.

Professor Turner, replying, thanked them for the compliment. With regard to the hollow casting, he would like to see it before passing an opinion upon it, but it was quite true, as Mr. Mason had said, that that effect might sometimes be prevented by putting in a piece of cold iron and so increasing the rapidity of chilling.

CORRESPONDENCE AND QUERIES.

(Edited by C. E. Allen.)

(Replies to Queries in this Column will be gladly received.)

Manganese Bronze. — "Inquirer" asked in our November issue for some information regarding the working of manganese bronze, its general difficulties in casting, how to obviate them, and the best method of manipulation of castings to stand air and fluid pressure.

In reply to "Inquirer" in your last issue anent the working of manganese bronze, mixing manganese bronze is a difficult proposition, and unless used by the foundry in large amounts it is cheaper to buy the ingots, care, of course, being exercised in the purchase thereof, as there are some brands on the market which are little better than the common bronzes. In re-melting, an allowance is made of 1 lb. of zinc, to each 100 lbs. of mixture for each re-melt after the first one. Overheating should be avoided as much as possible, as over-heating the copper results in a loss of zinc, and some zinc is bound to be lost, no matter how careful the operation; but in case of over-heating the allowance of zinc should be increased to 2 or 3 lbs. Over-heating within certain limits causes expansion equal to the degree of heat, and, therefore, has a tendency to destroy cohesion, thus hindering the formation of the homogeneous alloys, thereby reducing the tensile strength and toughness. In re-melting for castings all manganese alloys should be made under exclusion of air as far as possible, and it should be heated till it flares zinc fumes freely, then removed from the furnace, and skimmed until the flaring ceases, after which it should flare zinc flames again, as it is poured into the mould. Manganese bronze is so much higher in tensile strength and elastic limit than other bronzes, that it can be cast in much smaller section for the same strength. It can also be cast in very delicate and intricate shapes, as it flows very freely in the mould, and has been cast as thin as $\frac{1}{32}$ of an in. for motor castings. Many founders give a guarantee that test bars cast on castings will give a tensile strength of 65,000 lbs., and an elastic limit of 30,000 lbs., and an elongation and reduction of area of 25 per cent.—C. E. Allen.

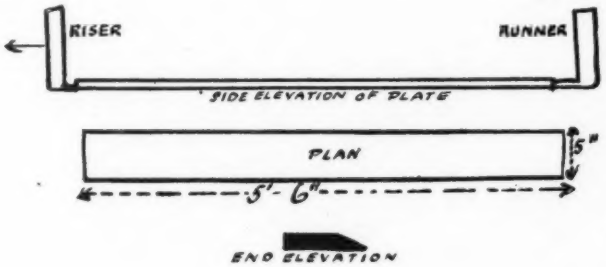
"Subscriber" asked in the October number of the FOUNDRY TRADE JOURNAL for information as to the best mode of transmitting air or blast to the cupola with the object of bringing down the metal hot, with minimum of coke, and in the shortest time.

In reply to "Subscriber," *re* Blast for Cupola in your issue for October. Having had charge of cupolas, the blast to which has been transmitted from a stand pipe and also through an air-belt, I consider the best mode of transmitting the blast for rapid and economical melting would be from an air-belt to the cupola. The air-belt should be at least 40 per cent. larger in sectional area than the combined tuyere area. The reason for this is where a cupola has an air-belt the air should be brought in at what is practically the end, and blow round the belt, and not be brought in at the bottom or back, and impinge against a flat surface; you don't want to choke the blast, but to get it into the furnace. These air-belts vary in depth from 12 in. to 24 in., the former usually having four tuyeres and the latter eight tuyeres. If your pipes are too small, or they are rough inside, you will lose a considerable amount of air by friction. Then again, if you try to make the air turn sharp corners, it will not do it. You are not dealing with compressed air as used for many purposes in a foundry, and which will go anywhere; the pipes can be taken; but you are dealing with moving air which is being propelled with a fan or a blower, and in which the compression can only be feeble in any case. For this reason, your pipes should be larger than the fan outlet, and they should be smooth inside, and all bends should be of long radius; if the pipes are as nearly straight as possible from the fan to the cupola, so much the better.—C. E. ALLEN.

CASTING GUN-METAL PLATES.

To the Editor of the FOUNDRY TRADE JOURNAL.

SIR,—Lately we have been engaged in casting a number of gun-metal plates about 5 ft. 6 in. long, 5 in. broad and ¾ in. thick. The difficulty has been in getting a clean, sound casting, free from flakes on faces on being machined. These castings have to be planed and ground on all faces, therefore requiring castings to be spotlessly clean, or otherwise they are rejected in the machine shop. The flakes, aforementioned appear as soon as first cut is taken with plane; on being finished with plane they are ground. This grinding soon rubs all flakes out, and when complete you cannot tell that they have ever been in the casting. Our metal has been from following mixture, viz., 90 per cent. copper, 10 per cent. tin, and about 1 lb. of zinc added as flux for copper. The mould is prepared in the ordinary way, and skin-dried with hot plates; immediately it is dry it is cast, therefore the mould is warm when cast. We have tried aluminium as flux but with worse results; the castings fluxed with aluminium have been full of small cavities on top side of plate, looking like a blown casting.



Our method of casting has been as per accompanying diagram, run in at one end with riser out of the other, the runner being plugged on till the runner box is full, and then it is raised.

I should esteem it a favour if you, or any of our fellow readers, can throw any light on a method of fusing castings from flakes. Thanking you in anticipation.

Yours, etc.

RANDOLPH.

MELTING FINE TURNINGS.

To the Editor of the FOUNDRY TRADE JOURNAL.

SIR,—Can any of your readers help me out of a difficulty. I have to melt a large quantity of turnings and borings of an alloy which contains zinc, aluminium, and a little iron. I have tried to reduce them to ingot but without success. I have tried both in a crucible and at a low heat in the ladle, and with and without flux; but in each case, as soon as the melting point is reached, the whole mass fuses, and is completely oxidised. I should be glad of any suggestions, as the borings are valuable metal, and we want to utilise them if possible.

Yours, etc.

"A READER FROM THE BEGINNING."

MIXTURES FOR MOTOR CYLINDERS.

To the Editor of the FOUNDRY TRADE JOURNAL.

SIR,—Would you be kind enough to give us some idea as to what the best mixture for casting cylinders of motor engines should be. Thanking you in anticipation.

W. B. S. G.

STEAM HEATED CORE OVENS.

To the Editor of the FOUNDRY TRADE JOURNAL.

SIR,—Would any of the readers of your journal inform me if they know of any core ovens that have been heated successfully by steam or water pipes, if so, what temperature was obtained?

Yours, etc.

A SUBSCRIBER.

"THE FOUNDRYMAN: PAST, PRESENT, AND FUTURE."

To the Editor of the FOUNDRY TRADE JOURNAL.

SIR,—In your November issue, I observe in your report of the meeting of the Birmingham Branch of the British Foundrymen's Association that their esteemed President, Mr. R. Buchanan, refers to a letter which appeared in the October issue of your journal, and signed "J. P.," initials which, by the way, I suppose were due to an error in description, as the letter was actually signed "W. R." and appeared so subscribed I am very pleased to see Mr. Buchanan in full accord with myself on this matter, and if we can continue to keep pegging away, there cannot be the slightest doubt but that the Admiralty will in the end see it to be a duty to appoint moulders as inspectors for at least castings, in Government contract work.

However, I would not be one to support the principle enunciated here without the applicant being prepared to undergo an examination of fitness for whatever service he was offering to perform, which, not too severe, would be based on an apprenticeship in the foundry. He must also give proof of an all-round practical knowledge of moulding and casting. This, together with other points of foundry technique, suggests itself as a fair basis of examination for Admiralty inspectors of castings. The qualifications at present are not great, and I am afraid that there are but few enjoying these appointments who, if put through a test as here suggested, would come out very well.

The gist of my previous letter was to support the principle of moulders as Admiralty inspectors only, and in no way would I like my name to be associated with the condemnation of the so-called doctoring of the famous rudder casting for H.M.S. "King Edward VII." any more than I would with that of its praise, because I know not whether the exposure was due to malice or otherwise. But this I do pretend to know, that "burning" and electric welding has, in the hands of most experienced men, proved a good finish to many a first-class job.

It is not so much the process of "burning" that is at fault as the incapacity of many who attempt it and their results, which intensify distrust in accepting castings thus treated. But whether burning be recognised or not, it certainly should never be resorted to unless the casting that is operated upon be subjected to a hydraulic test or otherwise afterwards.

It is worthy of note that burning, from an engineer's point of view, is a terrible crime, until an accident of breakage occurs in the machining or fitting shops, and then all sorts of methods for burning are advanced by those who, as a rule, are the first to cry out against the practice.

If I may be allowed to digress a moment, I should like to say that founding, in its broadest sense, is a branch of mechanics, and the more we study the

latter in general the more and the better equipped will moulders be for the abstruse problems of foundry practice.

The past, present, and future of the moulder is always of interest to practical men. And the more the British Foundrymen's Association work for an advanced intellectual propaganda, the highest possible good must inevitably follow, both in output and quality.

Indeed, the day is almost past for the old moulder who could do but little more than feign regret at his wasters, or, on the other hand, point to his forehead and laughingly say: "It was all there," when he struck a success. Rule-of-thumb can never do more than grope by chance. The man who has his practice fortified with theory, and can view his work in section from his bottom binders, drag-box or flask, right up through to the top of his pouring basin in any given job, is the moulder of the future.

I beg to subscribe my name as before,

"W. R."

——o——

GLASGOW MAN'S DEPARTURE FOR AMERICA.

On Saturday, November 9, Mr. George Heggie, for the past nine years in charge of the pattern-making department of Messrs. M'Dowall, Steven & Company, Limited, Milton Iron Works, Glasgow, sailed for America. The name is familiar in foundry circles, his father having been for a long time foreman pattern-maker at Carron Iron Works, while his brother, Mr C. Heggie, is Secretary of the Birmingham Branch of the British Foundrymen's Association. Mr. Heggie's departure is necessitated by the removal of a part of Messrs. M'Dowall's business to Laurieston, nearly all the pattern-makers having been discharged. At a smoking-concert Mr. Heggie was presented with a gold watch by his fellow employés, and his wife with a gold bangle, a purse of sovereigns also being handed to him by the directors of the firm. Mr. Britton, who made the presentation, spoke warmly of the recipient's good qualities, and expressed his belief in his complete success in America.

The chair was occupied by Mr. George M'Kay, for some time associated with Mr. Heggie as assistant.

——o——

Mr. J. A. Reavell has left the employment of Manlove, Alliott & Company, Limited, engineers, of Nottingham.

A FOUNDRY FOR BENCH WORK.*

By W. J. Keep and Emmet Dwyer.

On January 8, 1907, nearly the entire works of the Michigan Stove Company were destroyed by fire. Reconstruction was begun at once, and by July 1 of the same year they were entirely completed, having been built on modern lines, substituting alternating electric current and individual motors for belts, shafting and rope drives.

On account of poor light and lack of good ventilation on hot days, it was difficult to get moulders to work in the old foundry. The new works, although surrounded by high buildings, are comfortably cool on the hottest days, and the temperature does not rise much during pouring. Fifteen minutes after the heat is off the foundry is clear.

Before deciding on plans for the new works the writers visited several foundries, and found that of the American Stove Company at Bedford, Ohio, best suited to their needs. This plan was accepted with the modifications of an extra row of windows in the roof, and three monitors running crosswise instead of lengthwise.

The roof presents some new features as adapted to foundries. A small model was constructed in which an extra row of windows was placed at each side, in the central part of the slope, and the outer edge of each roof section raised to give the usual pitch of a gravel roof.

This arrangement allowed the windows in the roof to be 10 ft. high, and another row 10 ft. high was added on each side, which permitted the use of the ordinary gravel roof, instead of the usual felt roofing with cinders. The disadvantage of the usual form of roofing with the latter covering is that its steep slope does not permit of its being walked upon. The ordinary gravel roof has proved entirely practicable for the purpose.

The foundry is 128 ft. square; the other dimensions are approximately 50 ft. to the top of the monitors, 40 ft. to the highest point in the roof proper, and 30 ft. to the roof at the sides. The girders are of 18 ft. centres. As an economy in cost, a row of posts was used in the centre, instead of having one truss the full length of the span.

The foundations are of concrete, the

* Presented at the New York meeting of the American Society of Mechanical Engineers.

walls, 6 ft. high, are of brick 12 in. thick; the balance is constructed of steel, with a roof of 2½ in. matched pine.

The building is so nearly fireproof that it is not considered necessary to instal sprinklers. There are hydrants at two places, and fire hose, with 100 lbs. water pressure. There are no wooden partitions or wood work other than that covering the steel at the windows—which the architect, being more used to wood than steel construction, insisted upon using to make the building weather-proof—and the charging platform, the framework of which, however, is steel with mill construction floor 8 in. thick. It is intended when the wood is perfectly dry (for the purpose of guarding against dry rot) to cover the upper surface with sheet metal and the under surface with some kind of fireproofing.

The height of 30 ft. at the sides of the building is to allow a deck to be erected at some future time on the line of the top of the first row of windows. The present plan is to begin the deck 10 ft. away from the side windows, making it wide enough to accommodate one row of moulders, with a gangway at the edge toward the centre of the foundry. The under side of the deck will be 12 ft. from the foundry floor, and the deck floor about 7 ft. from the underside of the lowest member of the truss.

The floor is of brick, laid in cement. One corner, 18 ft. by 60 ft., is used for a core room, and besides there is ample room for 86 bench-moulders.

It has not been found necessary to open the monitor windows, it being cool enough when they are closed, but every second window can be swung open. All of the others are stationary except the bottom row, where each window swings open.

Some difficulties were met in removing the cupola from the old location to its present site, a distance of 45 ft. It has a 72-in. shell, is 75 ft. high, lined to the top, and is estimated to weigh 76 tons. The local movers were asked to submit bids, the lowest of which was £120, and there was no competition for the order even at that price. Finally a house-mover agreed to move it for £35. There was no guarantee against accidents in any case.

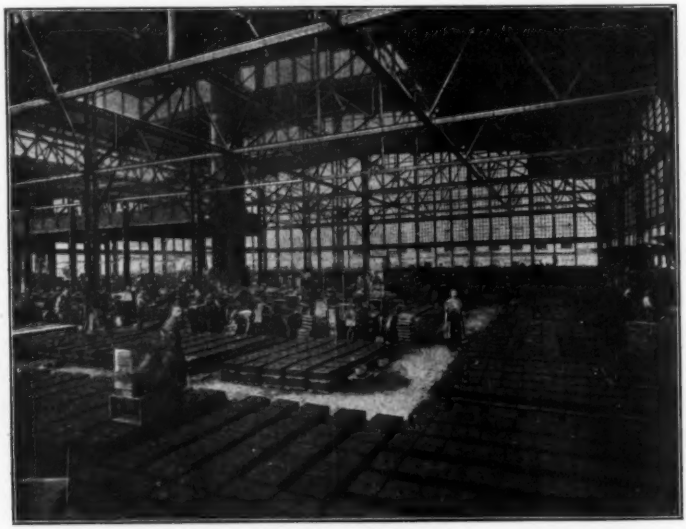


FIG. 1.—INTERIOR VIEW OF THE FOUNDRY.

The Company furnished ⅝-in. wire rope for four guy ropes, which were fastened at their outer ends by tackle, and provided the men to manage them.

Two timbers were placed under the cupola from front to rear, and one cross-wise. These and the cupola were raised

with ordinary movers' jack screws until 5-in. wooden rollers and timbers to roll on were placed beneath. A cross timber was fastened by chains on the under timbers, and jack screws between this cross timber and the ends of the timbers and directly under the cupola shoved the cupola along.

To insure its being kept plumb, a timber projected from the charging platform door, from which a plumb-bob was suspended by a wire. A plank fastened to the base of the cupola with a nail driven so that its head was directly under the point of the plumb-bob, told which way to raise the blocking. After everything was ready the cupola was moved in ten hours. The mover made a profit of £15, and the entire cost to the company was £45.

The foundry will be heated by the forced circulation of hot water, which is to be kept at 157 degrees. The temperature at zero weather is guaranteed to be 45 degrees. The radiation is estimated at 4,300 square feet of radiating surface, using 1½ in. pipe.

——o——

COCHRANE & COMPANY, LIMITED, of the Woodside Foundry, Dudley, are supplying the Devonport Corporation with 2,000 tons of 21-in., 18-in., and 15-in. cast-iron pipes and special castings, at a cost of £10,534 18s. 10d.

FOUNDRY CUPOLA AND IRON MIXTURES.*

By W. J. KEEP.

The Cupola.

IRON for ordinary castings is melted in a cupola, a vertical brick-lined cylinder, in which are charged coke and iron in alternate layers, while air is forced in by a blower.

The leading kinds of cupolas have the same general proportions which leave little room for improvement; by measuring a large number of cupolas, before any type had become common, and tabulating records of melting, the writer determined that proportions exert almost no influence upon the melting efficiency. The results depend rather upon the skill or care of the melter.

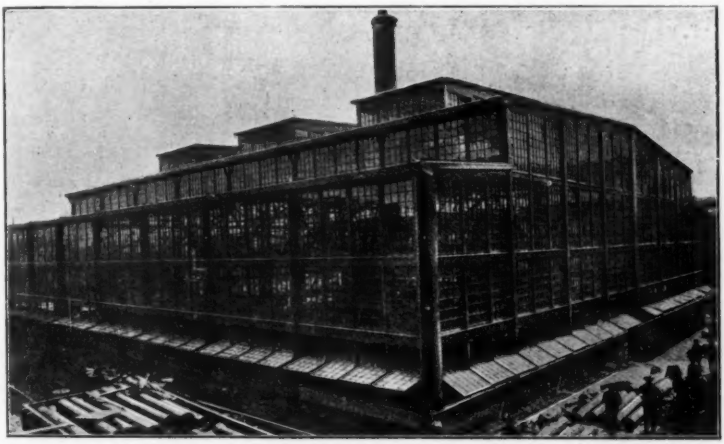


FIG. 2.—EXTERIOR VIEW OF THE FOUNDRY.

A special form of cupola is described in this article; but so far as details of construction are concerned, there are as many opinions as there are designers, and as good results are claimed with other forms.

It does not pay to purchase a small cupola. A 72-in. shell may be lined with common red brick next to the shell and with fire brick inside to bring the inside diameter right—say, 36 in. for a small business, to be increased as the business

* Presented at the December 1907 meeting of the American Society of Mechanical Engineers, and to form part of Volume 29 of the "Transactions."

grows. Above the charging door the ordinary 5-in. lining may be used.

The Lining.

Every test the writer has made has shown that for ordinary melting of grey iron the cheapest stock brick may be used to good advantage.

Square bricks should be used wherever possible, and key or arch bricks only when necessary to turn the circle without leaving spaces between. A stock brick, whether square, split, key, or arched, will make as good a lining as the special shaped cupola blocks, and is much cheaper. If the stock bricks are laid so that their surfaces touch each other and all spaces are filled with a thin grout, the lining will last as long as if made with large blocks.

In procuring brick care should be used in the selection of its size. If "squared" or "straight" it should be 9 in. long, 4½ in. wide and 2½ in. thick (100 cubic inch). Good brick of these dimensions can be found at low prices. To produce a lower priced brick the size is often reduced to 8½ by 4¼ by 2½ in. (90 cubic inch.)

For special melting using steel scrap, or for continuous melting, a more refractory (and expensive) brick may be needed.

In building up the lining the bricks should be dipped in a thin hot grout, made of one-third fire clay and two-thirds sharp sand, and laid tightly against each other, allowing the grout to fill all spaces. At intervals of 2 ft. or 3 ft. all the way to the top of the charging door rings of angle iron should be riveted to the shell to allow any section of brick to be renewed without disturbing the rest of the lining.

The lining above the charging door will last as long as the shell. The lining from the top of the charging door to the point at which the iron melts (herein termed the melting point) is not cut away by heat, although it is worn by the friction of the charges, and even when but 5 in. thick will often last several years. At the melting point it is often necessary to renew the lining every six months if the cupola is run to its full capacity. The bosh will need renewing about as often. The brick below the tuyeres becomes friable on account of the contact of fluid iron, but will last twice as long as that at the melting point.

The usual lining is made of the same diameter up to the charging door, and as good melting can be done with such a lining as with any other shape. In the vicinity of the melting point, however, the lining gradually burns away, and it is customary to pick the slag from the surfaces and daub on a thick mortar composed of boiled fire clay and sharp sand, patching the holes with pieces of fire brick to bring back the original shape. But it will be found that the daubing is liable to shrink in drying out, and to fall off while the iron is melting. The accumulation of slag just below the melting point tends to build out the lining toward the centre of the cupola into a shape that it will retain indefinitely—a sort of overhanging bosh.

The construction herein described is to anticipate this natural action in the cupola by actually building the lining, in the first place, in the shape of this overhanging bosh. Make the lining 12 in. thick in the hearth; then form the overhang by making the lining 16 in. thick above the tuyeres; thence sloping back for the next 2 ft. to the thickness of 5 in. opposite the melting point and the rest of the way up.

By this construction the blast is carried to the centre of the cupola. The hot products of the combustion therefore do not cut away the lining opposite the melting point as they do with a straight lining; and the shell of the cupola opposite the 5-in. lining is no hotter than it would be with a straight lining 9 in. thick. The cupola can hold more iron, and the melting is therefore more rapid; moreover, as the lining is thicker just below the bosh, less fuel is needed for the bed and the melting ratio is improved.

The Charging Door.

The usual height of the charging door above the bottom plate is 12 ft., but 15 ft. of 17 ft. is practicable. The more iron there is in the cupola the better, as it becomes heated by the waste gases before it reaches the melting point, and is thus brought nearer the melting temperature; even at 17 ft., however, the iron has not become hot enough to melt by the time it gets to the melting point.

The charging door cannot advisedly be placed any higher, as the first charge would have too far to fall on to the bed of coke. Moreover, at times when the bottom cuts through, or the blast apparatus is closed down, the bottom must be dropped when the cupola is full, and sometimes it is necessary to use a rod to make a hole through the slag that does not fall through when the bottom is dropped, which is inconvenient when the door is more than 17 ft. above the bottom plate.

There is no need of a tight charging

door. A wire screen let down in front of the opening when the last charge is in will keep sparks from blowing out.

The Tuyeres.

The distance of the tuyeres from the cupola bottom depends upon whether anthracite coal or coke is used, and upon the kind of castings made. In using coke, where the iron runs out as fast as melted, the distance from the bottom of the tuyeres to the sand bottom should be about 12 in. For machinery castings the distance should be such that the iron can accumulate without running out of the tuyeres.

The shape or number of the tuyeres is not of great importance, but the usual construction is of cast iron, bolted to the shell, and of a size to admit enough air to burn the coke in the shortest possible time. The admission of air depends on the friction in the blast pipes at the tuyere openings and the blast pressure at the tuyeres, and the size should be calculated for about 8 ozs. pressure.

It is usual to keep the top and bottom tuyere walls nearly horizontal. The sides however, should be flared toward the centre of the cupola to compensate for the partial choking of the admission of air by the fuel and chilled slag lying directly in front of the tuyeres. The overhanging bosh, described above, helps to form a continuous air chamber and prevents clogging, by melted iron and slag, all around the cupola in front of the tuyeres, thereby insuring a gentle and even admission of the blast that does not injure the lining. By giving a slight inward flare to the openings, the tuyere casting can be made with a green-sand core, but they may be made so wide at the inner end that they nearly or quite touch each other. One or more supports are cast near the inner openings to prevent the top of the tuyere from sagging. The shape must be such, however, that when melted iron accidentally rises and chills, it can be pushed out without injury to the tuyere.

A very good way to form a practically continuous tuyere is by means of plates or segments 1 in. thick, and equal in width to the thickness of the lining at the tuyere circle. When the lining is built to within an inch of the blast openings in the shell, a circle of the segments is laid on it. Cast-iron blocks 3 in. wide and 4½ in. high are placed on this, even with the front of the circle and about 7 in. apart. Another circle of segments is laid upon these blocks and then the regular brick lining is continued. This construction leaves a 3-in. continuous space unbroken by partitions, next to the shell, and permits the air to enter at all points with equal force.

The Bottom.

The bottom is made of sifted sand from the gangway, dampened, tempered, and riddled. The sand should be shovelled in through the breast and stamped with the feet, and then rammed as in moulding. Make a close joint around the edges, and have the sand at least 2½ in. thick above the cupola bottom at the level of the spout lining, (not the bottom doors) and with a level and straight edge make it slope up toward the back ½ in. in each foot.

If the bottom is too wet, or is rammed too hard, it is liable to lift up and crack and let the melted iron cut through the bottom doors. To prevent this accident, drill the doors with ½-in. holes 4 in. apart, so that the steam and gases from the sand bottom can escape.

The Breast and Tap Hole.

To make the breast, hold a board against the inside of the cupola and ram from the front a mixture of one-third part fire-clay, and two-thirds burnt moulding sand wet with clay-wash and tempered with new sand.

Form the tap hole with a smooth stick, 15 in. long, and tapering from a diameter of 2 in. at one end to 1 in. at the other, laid in the breast with its small end against the board. When the breast is rammed full, remove the board, shove the stick in 2 in. and scrape away the breast at the front to an arch until at the tap hole it is only 1 in. thick.

Operation.

Charging and Running.

In a 72-in. cupola use about four bushels of shavings, spread some over the bottom and pile them up around the sides to the tuyeres in front of which lay shavings and splinters. Then lay kindlings evenly over the whole bottom and set soft cord wood on end all around the sides, with some short pieces in the centre.

For the bed charge 1,200 lbs. of coke, and light the fire at the tuyeres and at the tap hole two hours before the wind is to be put on. Build a wood fire all along the spout (which has been lined 1 in. thick with the same mixture as the breast) and light the fire in front of the breast, leaving the tuyeres and tap hole open until the coke is well ignited. After

the wood is all burned out, close the tuyere doors and charge on 500 lbs. of coke. Bend the ends of a rod, at right angles, in opposite directions, of such length that when the upper end hangs on the charging door sill, the lower end will be 2 ft. above the top of the tuyeres. Add enough coke to reach up to the lower end of the rod and spread evenly on this coke one-half of the first charge of pig-iron and scrap, and 100 lbs. of coke, then add the other half charge of iron. This makes 1,800 lbs. of coke on the bed, and 4,800 lbs. of iron, consisting of 3,200 lbs. of pig-iron and 1,600 lbs. of sprues and scrap (for stove plate). All the rest of the charges consist of 250 lbs. of coke and 3,000 lbs. of iron. (19.50 lbs. pig and 10.50 lbs. of remelt.)

Scatter over each charge of coke two shovelfuls of screenings from the gangways, and two of limestone, broken as small as an egg. Continue charging until full to the charging door. If the fire is lighted at 12 p.m. the charging should begin at 12.30 p.m. and the wind put on at 2 p.m. Stop the tap hole at 2.10 p.m., and tap out at 2.15 p.m. With 20 charges (31 tons) the wind should be off at 5 p.m. Fuel ratio 9 to 1, and the melting 10 tons per hour. (Cupola 72 in. shell.)

The Blast.

Fast melting fuel must be burned rapidly. With free entrance for air and with a positive blower the speed of melting can be increased by increasing the blast up to 18 ozs. pressure. No further increase of speed in melting is obtained with 22 ozs. pressure, and with 26 ozs. the melting will be slower, showing that more air is blown than can be used. About 14 ozs. is the best pressure for any kind of blower or cupola. When speed is not required, a lower pressure (perhaps 6 or 8 ozs.) may give more economical results.

As good results are obtained with one kind of blower as with another. Those who use a positive blower think they get a stronger blast, but it does not pay to change if the blower already in use is large enough.

Advantages of Hot Iron.

Iron should be melted hot, whether it is to be poured hot or dull. Hot iron is fluid, the gases and slag can separate and the castings will be even in grain and free from blow-holes.

It is important to have a hot cupola before the iron begins to melt. Whether the cupola is small or large, the fire should be lighted two hours before the iron is needed, and the fuel should be well lighted all over the centre before the iron is charged.

Slagging.

Slag should be drawn off and not allowed to reach the tuyeres. The slag hole is a 4-in. square hole left in the brick lining opposite the tap hole with its top about 4 in. below the bottom of the tuyeres. It is lined, and its upper end is stopped with daubing clay. Slag should be allowed to accumulate until it is nearly up to the tuyeres, as it protects the melted iron from the blast and strains out the dirt. Before the slag runs out of the tuyeres the slag hole is opened just enough to let the slag run as fast as it forms. By arranging a trough, a crust will form, covering the hot stream beneath; and by raising the crust a little with a bar it will set and form a channel which will keep a steady stream of slag flowing with no noise or escape of wind.

Saving Iron from the Bottom.

A way to save iron dropped from the bottom of the cupola which has been found better than a cinder mill or any separator is as follows: After the wind is off and all melted iron has run out of the cupola, make a circular dam of sand about 4 ft. in diameter in front of the cupola and about 4 in. high. Lay a tapping bar across the spout, and with a piece of 1½-in. shafting, 8 ft. long, ram in the breast and let all of the slag run out on the floor. The iron will settle under the slag. When the slag is all out, drop the bottom, wet it down, and draw it out. In the morning, there being no slag, the bottom can be picked over by hand. All iron is thrown to one side, and any piece of sand bottom, or of slag not containing iron, is discarded. All coke large enough to use is saved; and all small coke and iron is shovelled up and taken to the scaffold, to be thrown in, with all skulls and sweepings containing iron, when the last charge has settled some distance down. The small coke holds down the blast, improving the last melting, and drops again with the bottom. The cupola is so hot that this iron is fit for use for almost any casting.

Fuel Ratio.

For heavy machinery castings and car wheels, with large cupolas, and when the iron need not be as hot as for small castings, sometimes 18 lbs. of iron are melted with 1 lb. of coke, counting in the bed and not deducting iron or coke dropped with the bottom. For ordinary castings

it is not economical to run any risk of having dull iron, because the loss of castings would be greater than any saving of coke.

For stove castings, for which the iron must be as hot as for any work, a fuel ratio of 9 to 1 can be maintained constantly with a 72-in. cupola, using a coke bed of 1,800 lbs. and melting 30 tons in $2\frac{3}{4}$ hours. To obtain such a ratio it is not necessary to break the pig-iron, but all scrap should be broken as small as the pig-iron, so as not to leave voids. The coke, pig, and scrap must be charged uniformly. It is better to charge one row of pig-iron flatwise around the circumference, then another row inside of this, and so on until the centre is filled. One ton of pig-iron will make about one thickness all over.

Stove plate, sprues, and scrap, weighing half a ton, will take more room than the pig-iron, and 260 lbs. of coke will completely cover the iron charge. The charge for stove plate will be 250 lbs. of coke, 1,950 lbs. of pig-iron, and 1,050 lbs. of remelt. On the bed the iron charge is 3,200 lbs. of pig and 1,600 lbs. of scrap, and the regular charge of 3,000 lbs. of iron and 260 lbs. of coke then continues through the heat.

Greater economy can be obtained if the coke is reduced on the last three charges, and sometimes the cupola will be so hot that the last charge can be melted with very little coke. The smaller the coke charge the faster the melting, provided sufficient coke is used to melt the iron hot. For fast melting, care and cleanliness are essential; no dirt or dust from the charging platform must be shovelled into the cupola, as it will prevent the iron from settling evenly.

Quality of the Coke.

The quality of the coke is one of the most important things in iron melting, because the iron is in constant contact with the fuel. Coke should contain about 10 per cent. of ash so as not to crush by the weight of the iron, or break up by the heat. If it contains too much volatile matter it will melt and clog the cupola, but the percentage of volatile in good and bad coke varies so little that it cannot be determined by analysis.

The sulphur should not exceed 0.75 per cent., but very often amounts to 1 per cent. and over. It is estimated that with 0.75 per cent. of sulphur in the coke 0.03 per cent. will enter the casting; and as the sprues and bad castings are remelted each day it is difficult to keep the sulphur in the castings below 0.08 per cent., which is the limit. In machinery scrap and stove-plate scrap sulphur is estimated at 0.08 per cent. Therefore, if the coke contains more than 0.75 per cent. of sulphur it is very difficult to use scrap enough to give a close grain without exceeding the above limit, and thereby causing hard spots and blow-holes in the casting.

Since the great demand by blast furnaces for beehive-oven coke, it has not been as reliable as when the founder could refuse a car-load which did not give good results. Retort-oven coke can be made of uniform quality and it is very satisfactory, but does not look as well as beehive coke.

The Flux.

Limestone is the best flux, and in a slight degree lessens sulphur; but its chief use is to make the slag fluid enough to run out of the slag hole, and to keep the cupola clean, especially when the bottom is dropped.

It is a question whether the special fluxes on the market do as much good as is claimed, but they are worth a trial. Fluor-spar is more efficient than limestone, but is more expensive.

Iron Mixtures.

Chemical Composition and Physical Qualities.

It is physical quality that the founder requires, and he would not trouble himself about the chemical composition were it not that by varying it he can vary the physical quality to some extent.

By decreasing sulphur, or by increasing silicon, the casting will be made softer. By decreasing sulphur, or by increasing silicon, or phosphorus, or both, fluidity is increased, and the iron is greyer and has less shrinkage. By increasing the manganese the sulphur is decreased or rendered less harmful.

But the physical quality of the iron charged, the conditions under which the iron is melted, and the manipulation of the fluid iron also materially influence the physical quality of the casting, irrespective of the chemical composition.

Pig-Iron.

Close-grained and strong pig-iron is likely to make castings having those characteristics. The close grain is generally accompanied by low silicon and sometimes by high sulphur, but it may have been caused by the original smelt-

ing conditions, *i.e.*, whether the blast furnace was cold or hot. Close grain in a soft casting generally means that it is strong, but for the closest grain and the greatest strength the casting is generally as hard as can be tooled.

Another reason for using close-grained, low-silicon pig-irons, and pig-irons low in phosphorus, is that they set more quickly, thereby preventing internal shrinkage and porosity. Large castings cool slowly; the interior is fluid a long time after the exterior has become solid, and contracts more and more as its temperature lowers, so that when its centre reaches the freezing point there is not enough bulk to fill the space. In solidifying it crystallises on the crystals already formed, resulting in a very loose grain at the centre; and finally, as the last iron becomes solid, a true cavity is left. Thus we have a shrink hole surrounded by a spongy iron. By feeding hot fluid iron to such a centre through a channel which is kept open by churning with an iron rod, every part of the casting can be made solid.

By using northern irons made from Lake Superior ores the tendency to sponginess is lessened because they set quicker than southern irons. Or, if an iron chill can be placed in the mould in a wall very near the spot that would otherwise be spongy it will set the metal quickly and prevent the trouble.

The Scrap.

Castings made from scrap iron of the same general size and grain as is desired in the casting, and cast under practically the same conditions, may be expected to have a similar grain—or a tendency toward a closer grain which would require to be offset by the addition of a small amount of a more open pig-iron.

An unduly coarse grain in the scrap will close up somewhat in remelting, or close-grain pig-iron may be used with it. Small, close-grained scrap, remelted for making a large casting which cools slowly, having a relatively higher silicon will have a coarser grain.

Scrap is not ordinarily analysed, though it often constitutes one-half the total mixture. Silicon runs 1.50, 2.00, and 2.40 per cent. in heavy, medium, and small soft scrap, respectively, and the sulphur is about 0.08 per cent.

In selecting scrap for a mixture, throw out all wrought, burnt, malleable, and chilled iron, and all steel.

Stove-plate scrap is very close grained, with sulphur about 0.08 per cent., and silicon about 2.75 per cent. For machine castings it closes the grain and adds strength, but its silicon is not as effective as in pig-iron because of its high sulphur and rather low carbon. The loss in weight during melting is excessive.

Select machinery scrap the size of the castings to be made, and break it small enough to melt in the cupola as fast as the pig-iron.

Qualities of Iron Produced.

Following are chemical compositions and physical qualities desirable in irons for various kinds of work, and some mixtures that will give them.

Hard Iron for Heavy Work.

Castings for compressor cylinders, valves, high pressure work, etc.

Chemical composition: Si. 1.20 to 1.50 per cent.; S. under 0.09 per cent.; P. 0.35 to 0.60 per cent.; Mn. 0.50 to 0.80 per cent.

Physical qualities: Transverse strength of a test bar 1 in. square and 12 in. long, 2,400 to 2,600 lbs.; tensile strength of same bar 22,000 to 25,000 lbs.; shrinkage in yokes, 0.160 in.; chill in yokes, 0.25 in.

Mixtures: Steel scrap to the amount of 10 to 25 per cent. may be added in the cupola. In a foundry running both air furnaces and cupolas, for castings of over 15 tons, one-half of iron from each may be mixed in the ladle to give strength. When the amount of steel exceeds 10 per cent. a very small quantity of aluminium should be used in the ladle to increase fluidity. It will remove all gases, prevent blow-holes, and give a very close grain. A piece of pure aluminium wire $\frac{1}{4}$ in. in diameter, and 1 in. long, for each 100 lbs. of iron, is sufficient; do not use so-called "casting aluminium." To insure a perfectly sound interior, make large castings as hard as will allow of machining, by keeping the silicon as low as possible. Select close-grained foundry iron low in silicon, or mill iron if the grain of the foundry grades is too coarse. A close grain in pig-iron accompanies a higher sulphur content which is due to a cold furnace. Charcoal pig-iron gives a close grain with low sulphur.

Although using scrap closes the grain, use it sparingly for the strongest castings—sometimes not more than 10 per cent., to avoid introducing sulphur. It is safer to use close-grained pig and steel scrap. For extra strength, use 1 to 10 lbs. of ferro-manganese, either in lumps in the cupola or granulated in the ladle.

The best way to close the grain and prevent sponginess is to charge 100 lbs.

of cast-iron borings with each ton of the mixture packed solid in a covered wooden box 6 in. deep. The box settles down to the melting point before the wood burns, and then the borings melt and mix, without more than 10 per cent. loss. Steel borings and chips can be used instead, but aluminium is needed in the ladle. Do not mix cast iron and steel borings in the same box.

In calculating mixtures for heavy castings, allow 1.50 per cent. silicon and 0.10 per cent. sulphur to be contained in the scrap.

Medium Iron for General Work.

Castings for low-pressure cylinders, gears, and pinions, etc.

Chemical composition: Si. 1.50 to 2.00 per cent.; S. under 0.08 per cent.; P. 0.35 to 0.60 per cent.; Mn. 0.50 to 0.80 per cent.

Physical qualities: Transverse strength of a test bar 1 in. square and 12 in. long, 2,200 to 2,400 lbs.; tensile strength, 20,000 to 23,000 lbs.; shrinkage 0.154 in.; chill 0.15 in.

Mixtures: Nos. 1, 2, and 3 foundry iron. Home and foreign scrap up to 50 per cent. of the whole is allowable for the best castings; or more with carefully selected scrap. In calculating mixtures, allow 1.75 to 2.00 per cent. silicon and 0.10 per cent. sulphur in foreign scrap.

Soft Iron.

For general car and railway castings, pulleys, small castings, and agricultural work.

Chemical composition: Si. 2.20 to 2.80 per cent. (with less the castings are hard, and with more they are too weak). For large castings, 2.40 per cent. is a good average; S. under 0.85; P. under 0.70; Mn. under 0.70.

Physical qualities: Transverse strength bar 1 in. square by 12 in. long, 2,000 to 2,200 lbs.; tensile strength 18,000 to 20,000 lbs.; texture: to close the grain use as high a percentage of scrap as will give soft castings.

Iron for Frictional Wear.

Castings for brake shoes, friction clutches, etc.

Chemical composition: Si. 2.00 to 2.50 per cent.; S. under 0.15 per cent.; P. under 0.70 per cent.; Mn. under 0.70 per cent. The addition of spiegeleisen increases hardness.

Calculating the Composition of an Iron Mixture.

A variation in silicon will make castings either hard or porous. The grain of the pig and the fracture of scrap are generally reproduced in the casting. The seller of pig-iron will give a close approximation to the chemical composition of his iron. The ordinary founder will not employ a chemist to make exact determinations.

Whether the founder uses the approximate of the accurate determination of his irons, he should calculate the chemical composition of his mixture.

Approximate Calculation.

Make up on paper the desired mixture, using irons in stock, and figure from the analysis, or estimate, of each pig-iron, the previously calculated composition of the home scrap, and the estimated composition of the foreign scrap. Multiply the pounds of each iron used by its percentage of silicon to obtain the pounds of silicon, and divide the aggregate weight of silicon in all the irons by the total weight of iron used, thus obtaining the percentage of silicon in the mixture. Deduct 0.20 per cent. for loss in melting. The remainder is the silicon in the casting; and if this is too high or too low to produce the desired percentage, vary the irons and figure again; and so on until you secure a mixture that will be satisfactory.

Precise Calculation.

To arrive at the composition by one calculation: If you are forced to use certain irons, determine their weights by considerations of economy, or of stock on hand (for example, enough home scrap to prevent accumulation; enough foreign scrap to cheapen the mixture or to close the grain, and the desired pig-irons) and compute the total silicon as before. Then adjust the percentage of silicon in the mixture by calculation from two pig-irons, one lower and the other higher in silicon than the percentage just computed, as shown in the following example.

An actual stove-plate mixture was desired, having 3.50 per cent. silicon in a charge of 3,000 lbs. The chemist's analysis card had accompanied each car of pig-iron. In this case no foreign scrap was used.

	Weight in pounds.		Per cent. Silicon.		Pounds Silicon.
Home scrap ...	900	×	3.25	=	29.25
No. 1 foundry ...	400	×	2.50	=	10.00
No. 2 foundry ...	350	×	2.18	=	7.63
No. 3 foundry ...	250	×	1.53	=	3.82
	1900				50.70
	3000	×	3.50	=	105·00
Needed	1100	×	4.94	=	54.30

D

That is, we needed 1,100 lbs. of an iron having 4.94 per cent. silicon to balance the mixture.

We had in stock No. 1 soft with 2.95 per cent. silicon, and Ashland silvery with 7.00 per cent. silicon; which balanced for the 4.94 per cent. as follows :—

		Differences.	Balances.	Total Parts.
4.94	No. 1 soft ...	2.95	− 199	205
	Ashland silvery	7.00	+ 2.06	199

1100 ÷ 4.05 = 2.72 pounds = 1 part.
206 × 2.72 = 560 pounds of No. 1 soft needed.
199 × 2.72 = 541 pounds of Ashland needed.
Take 550 pounds of each to make even weights.

This example will fit almost any foundry condition. The result can be checked by computing the silicon in each iron as follows :—

550 × 2.95	= 16.225
550 × 7.00	= 38.50
1900	= 50.70
3000 × 3.51	= 105.42

Allowing loss of silicon 0.20 gives 3.31 per cent. silicon in the casting. The actual analysis was 3.34.

If, on the other hand, you have plenty of each of the irons in stock and do not care what proportions you use, calculate as follows :—

	Differences.	Balances.				Parts.	Total parts.
Home scrap ...	3.25	− 0.25	350			350	
No 1 foundry ...	2.50	− 1.00		350		350	
No 2 foundry ...	2.18	− 1.32			350	350	2259
No 3 foundry ...	1.53	− 1.97			350	350	
No 1 soft ...	2.95	− 0.55			350	350	
Silvery ...	7.00	+ 3.50	25	+ 100	+ 132	+ 197	+ 55 509

3000 pounds = 2259 parts. 1 part = 1.328 pound.

Iron.	Parts.	Weight.
Home scrap	350	464.8 pounds
No. 1 foundry	350	464.8 pounds
No. 2 foundry	350	464.8 pounds
No. 3 foundry	350	464.8 pounds
No. 1 soft	350	464.8 pounds
Silvery	509	676.0 pounds
Total		3. 00 0 pounds

But you can only weigh differences of 50 lbs., so divide the 3,000 into multiples of 50. If you wish to do so, use 650 lbs. of home scrap.

Proof.	
650 × 3.25	= 21.125
450 × 2.50	= 11.25
450 × 2.18	= 9.81
450 × 1.53	= 6.88
450 × 2.95	= 13.28
650 × 7.00	= 45.50
3000 × 3.59	= 107.84

Losses in Remelting.

Loss of Iron.

The following are the only reliable published data on remelting losses of which the author knows :—

In a cupola lined to 52 in., one ton each of several different irons were melted at one time with the results given below. No iron was thrown away, and the data are reliable.

Kind of iron.	Pounds loss per ton.	Per cent.
A No. 1 Pig (Si. 2.70 per cent. S. 0.015 per cent.)	95	4.75
B Cleaned new stove plate	159	7.95
C Cleaned sprues from stove plate	130	6.50
D New stove plate with sand on ...	230	11.50
E New sprues plate with sand on	280	14.00
F Old stove plate scrap (rusty) ...	227	11.35

By pickling with hydrofluoric acid it was found that 33 lbs. of the 95 lbs. loss of *A* was sand purchased on the pigs. Milling a ton of *F* just as purchased showed that 50 lbs. of the 227 lbs. loss was rust.

Taking results from *A* to *F* :—

	Loss pounds per ton.	Per cent.
The calculated loss from a 37 ton heat (72 inch cupola)	116	5.80
The actual loss from a 37 ton heat (72 inch cupola)	88	4.41

In a small cupola with small heats the loss would be relatively greater.

MEMORANDA FROM THE 37-TON HEAT 72 INCH CUPOLA.

	Per ton melted
Shot iron recovered from the gangway	26 pounds
Good sand recovered from the gangway	111 pounds
Coke recovered from the bottom ...	57 pounds
Slag tapped out	207 pounds
Sand on pig from pig bed	30 pounds
Limestone used as flux	43 pounds

TEST BARS 1 INCH DIAMETER BY 12 FEET LONG

	Strength.	Shrinkage.
37-ton heat stove plate ...	380 pounds	0.149 inches
Remelted cleaned stove plate	390 pounds	0.162 inches
Remelted cleaned plate sprues	375 pounds	0.158 inches
Remelted old stove-plate scrap	377 pounds	0.202 inches
Remelted No. 1 Pig ...	410 pounds	0.149 inches

In large stove foundries the sprues and plate lost in pouring are charged into the cupola with sand on, it being cheaper to melt the sand than to mill it off; hence the large amount of slag. In machine foundries the gates and lost castings being more bulky, the loss in remelting would be less than in a stove foundry.

Boiling of the first iron on the cupola bottom and in the green ladles is likely to form a white core and grey surface in the first castings; therefore, pour unimportant work with the first 500 lbs.

Loss of Other Constituents.

By remelting, carbon is very rarely increased, and is generally decreased; more of it is in combined form than before, because the cupola is not as hot as the blast furnace, and because the sulphur is increased.

Silicon decreases about 0.20 per cent.; sulphur increases about 0.03 per cent.; phosphorus remains constant; and manganese decreases about 0.15 per cent.; when in the casting it is 0.50 per cent.

By using percentages of sulphur, phosphorus, and manganese, as in the proof, we can find the percentages of these elements in the casting. The object of varying the chemical composition is to control the shrinkage, hardness, and grain of the casting, and we must test these physical qualities to ascertain the result of the chemical variation.

For the mixture first calculated, a test bar ½ in. square by 12 in. long gave a strength of 430 lbs.; shrinkage, 0.126; chill, 0.06; and hardness, 23 degrees.

The analysis was: T.C. 3.43; CC. 3.27; Cd.C. 0.16; Si. 3.15; P. 0.958; S. 0.055 per cent.

Mechanical Analysis.

Turning the above the other way, we find that a shrinkage of 0.126 resulted from 3.15 per cent. silicon. We also know that a decrease of silicon increases shrinkage and *vice versâ*; therefore, if the shrinkage rises above 0.126, we must increase the silicon by using more of some iron high in silicon to bring it back, and if it drops below 0.126 we can use more scrap or hard irons, thereby decreasing the silicon and cheapening the mixture.

This regulating the silicon from the physical end is a mechanical analysis; and it is the only one, since shrinkage is the only physical quality that varies with a variation of silicon. Mechanical analysis is quick and inexpensive. It can be used by any founder and goes directly to the spot without any chance of mistake.

—o—

THE final meeting of the shareholders of the Union Rolling Stock Company, Limited, was held at Birmingham, recently. The liquidator submitted the accounts, which showed that the assets had realised £105,124, out of which £80,000 had been returned to shareholders in October, 1902, and a further and final dividend of £23,968 of surplus assets in January, 1903. The statutory resolution was formally passed, and the company dissolved.

THE FOUNDRY DEPARTMENT AND THE DEPARTMENT OF ENGINEERING DESIGN.*

By WILLIAM A. BOLE.

THESE notes have special reference to the design and manufacture of large and complicated castings; castings in which the material must be intrinsically strong and in which all of the various elements of a complicated casting must work harmoniously to accomplish the engineering purpose intended.

Small castings, as a rule, require much less consideration for two reasons. First: It is not usual to demand high strength in small iron castings because the designer will usually make a section thick enough to permit of pouring the metal—obtaining this information either from his own observation or by the foundryman's advice—and for most small objects the sections thus determined are more than ample for considerations of strength. Second: Thin castings, by virtue of their more rapid cooling, are almost certain to be stronger per unit section than would be the case if the same metal were poured into larger and heavier shapes.

Many large iron castings are, I believe, of questionable strength and of doubtful reliability, even though they have not as yet broken in service, because of internal strains and lack of harmony between their consecutive elements. This may be true even though the casting is poured out of iron of the best quality, and may be due to inconsistencies of design occasioned by lack of experience on the part of the designer, especially in the cooling and shrinking of the various parts of a large casting after being poured.

The physics of cooling, shrinking and synchronous contraction is a study which the foundryman should be better able to follow, and to become expert in, than the designer; and the engineering department of a manufacturing plant making large iron castings of complicated shapes would do well to consult foundry conditions very carefully before finally determining upon and accepting designs for such castings.

The foundryman's knowledge of the physics of the foundry should qualify him to anticipate some things not generally known to the average draughtsman, and often not known to the supervising engineer.

* Presented at the New York meeting of the American Society of Mechanical Engineers.

The usual drawing-room method is one of making assumptions in design by which sections of castings are regarded as beams of various sorts, loaded in various ways, as pillars, as sections in tension and sections in compression, etc. These assumptions are made as though the said members and said sections were of cold materials, put together in such a manner as to allow each section to remain normal to itself, as would be the case in building up a bridge truss, securing member to member by rivets or pins. Unfortunately for such assumptions the casting must go through the stages of molten, red hot, and cold conditions before it is in its final form, and what happens during these changes of state may entirely upset the engineering assumptions upon which its members were calculated, and when the casting is cold, some members which were expected to be in tension may be in compression, and *vice versâ*; others that had been intended for compression may be actually in tension. It is therefore necessary in designing to consider carefully whether the casting, after having passed through these formative stages, will ultimately be as the designer assumes.

Castings are often designed with a useless multiplicity of ribs, walls, gussets, brackets, etc., which by their asynchronous cooling and their inharmonious shrinkage and contraction, may entirely defeat the intention of the designer. He may find some of his walls, ribs, or brackets cracked before the casting is cleaned. It is sometimes possible to remove such superfluous walls, ribs, and brackets, and thereby obtain not only a lighter but a stronger and more dependable casting.

It is highly essential that the designer keep in mind, as nearly as he can imagine, the cooling processes through which the casting must pass and the effect which will be produced upon any given wall or member of the casting if it is cooled faster or slower than the other parts of the same casting. It would be difficult to set down any considerable number of rules governing this matter, but it may be of advantage to call attention to the necessity for careful study of this and of related subjects.

The outer walls of a casting, that is to say those which are more nearly adjacent to the sides and radiating surfaces of the flask, are naturally the first parts of a casting to lose heat, to fall in temperature, to begin to contract and decrease all their linear dimensions. The inner walls of the same casting, being more isolated from the outer and conducting surfaces of the flask, may remain hot for a much longer period than the outer portions; as a consequence the outer members of certain castings may cool and take on their ultimate dimensions while the inner members are still very hot. The latter will, of course, ultimately cool off by conduction, but they will also continue to contract until at normal temperature, and their freedom of contraction may be prevented by the already determined dimensions of the outer walls; as a result there is likely to be violent tension strains in the interior walls of such castings. Sometimes these strains are sufficient to cause rupture while the casting is still in the mould; sometimes the casting does not rupture until it is out in service, and even if it breaks in service the rupture may not be produced by stresses of engineering design, but may be due to the original asynchronous cooling of the various parts of the casting.

There are some castings which, by virtue of their shapes, can be speedily treated by the foundryman, and artificial cooling of certain critical parts may be effected in order to compel such parts to cool more rapidly than they would naturally do, and the strength of the casting may by such means be beneficially effected. As, for instance, in the case of a flywheel with heavy rim but comparatively light arms and hub; it may be beneficial to remove the flask and expose the rim to the air so as to hasten its natural rate of cooling, while the arms and hub are still kept muffled up in the sand of the mould and their cooling retarded as much as possible. Or in the case of a flywheel with an ordinary weight of rim and arm but with a heavy hub; the hub may be exposed and compelled to cool more readily than it naturally would, while the arms and rims are kept muffled in sand, and the synchronous cooling above referred to is at least approximated to a greater extent than if all parts were allowed to cool naturally.

It is often thought that large fillets are fine features of design in work of this sort, but many times they are highly detrimental to good results. Where two walls meet and intersect, as in the shape of a T, if a large fillet is swept at the juncture, there will be a pool of liquid metal at this point which will remain liquid for a longer time than either wall because of its lessened facilities for quick cooling, and this pool of liquid

metal is bound to act as a feeder, supplying metal for other parts lower in the mould that may shrink sooner, the result being in practically every case a void, or "draw," at the juncture point, bad enough in any case, but made worse by the presence of the large fillet. Of course there may be trouble from such intersections where no fillets at all are used, but the fillets should be kept small with the idea of allowing both walls and juncture to remain as nearly uniform in thickness as possible, and to have as nearly as may be the same capability for simultaneous shrinkage and solidification.

Among other classes of difficult castings I would place jacketed cylinders in the list of castings requiring careful consideration in design. In considering the case of a gas engine cylinder which is to be jacketed, the inner wall which resists the strain of explosion must be quite thick in order to afford the requisite strength against explosion pressures of ordinary nature, and also against abnormal pressures due to preignition and other causes. A cylinder of this sort, whose internal diameter might be 40 in., could well have a thickness of cylinder wall amounting to 3 in. or more. The outer wall forming the jacket has only to stand the ordinary pressure of the cooling water, which might be quite low, often not exceeding 60 to 80 lbs. per square inch, even where water is used direct from the city mains, and an outer jacket wall 1 in. thick might, on ordinary engineering assumptions, be regarded as ample to care for this pressure.

If the cylinder wall and the jacket wall are continuous, that is to say, if each extends rigidly from one end of the cylinder to the other, there is likely to be trouble when such a cylinder is cast or cooled, and even if it does not break at the start it is quite likely to break in service later because of the fact that a wall of metal 1 in. thick, located out near the sides of the flask which act as cooling media, will not shrink in time with the inner wall whose thickness is three times as great, and whose opportunity for radiation is quite inferior. It is reasonable to expect that the outer wall will cool first; will take on its final dimensions while the inner wall is still very hot; at a later period the inner wall will shrink to normal temperature, and will find that its desire to contract is restricted by the compressive strength of the outer jacket wall, and the effect is a high degree of tension in the working cylinder wall. In such a case one good feature of design is to interrupt the jacket wall so that the inner or working wall may have its own way and be unhampered in contracting; afterwards it is closed up and rendered water-tight by suitable mechanical means.

In such a case as that just cited, if the jacket wall must be cast continuous with the cylinder wall, it should not be designed solely in connection with its own theoretical stresses, but should be thickened up and made to approximate the working cylinder wall, so that it may cool down and contract more nearly simultaneously with the same, thus relieving the casting of stresses produced by asynchronous cooling. Such outer walls, and all such attachments to a large casting, as bosses, pads, and the like, should be designed, not alone out of consideration to the working strains which will be applied to such bosses or pads, but the tendency of the iron to chill at such spots must be considered, and ofttimes the pads or the bosses require to be made several times as large as mere reasons of strength would dictate, to avoid a hardening and whitening of the iron in thin sections that would prevent its being machined to required dimensions.

After the foundryman has accepted the design and begun the work he may have several things to do in order to produce a reliable casting. If it is a cored casting he must guard against the cores being so strong that when confined within the contracting casting they will produce rupture of the metal. Among the usual means employed for producing a collapsible condition of core may be mentioned the use of sawdust, or coke or ashes, or a combination of them all, some of which ingredients will burn out as the casting cools, and provide thereby for a collapse of the core. In other cases, removable pieces, collapsible core arbors, straw wrapped core arbors and the like, tend to prevent castings from cracking because of an unyielding core.

In order to serve engineering purposes, castings should be not only apparently sound but really so. For this purpose risers and sink heads should often be employed on iron castings where they are not at present used. Steel foundry conditions compel such precautions to insure soundness, but in large ironfoundry work interior cavities may exist without detection, and some of these may be avoided by the use of

suitable feeding devices, risers and sink heads. If risers are not employed, the upper or cope side of the casting is likely not to be solid, because of the metal in the upper portions flowing or bleeding away from the interior of these sections to feed the shrinkage and the contraction in the lower portions of the casting. Gravitation is at work here as elsewhere, and as the sections of the casting that are lowest cool and pass from the liquid to the solid state, the diminished volume of the solidified iron produces demands for fresh liquid metal from above to fill the voids, so that the upper portion of the casting is in such cases sacrificed for the benefit of the lower part. The top surface of such a casting may apparently be solid, but if drilled deeply, as for stud bolts or other purposes, it is likely that cavities and extreme openness of grain will be disclosed. In some such cases good can be accomplished by the use of local chills placed under the top flange, if a cylinder for instance, which chills will set the metal in the flange before it has time to feed out of this region into any lower portion of the casting.

If specifications do not call for sink heads or risers, they may not be applied in the foundry if the foundry has no interest in the design, and the resulting casting may be quite otherwise than as the engineering department had anticipated. The making and the cutting off of the sink head costs the foundryman heavily, and he may not be willing to spend the extra cost involved in the sink head method, and he may really not know whether the requirements are severe or otherwise.

In some large castings, intrinsic strength per unit section may not be a serious requirement. The amount of metal provided for reasons of mass, or for other reasons, being so ample that the working strains per unit section are low, and are easily complied with. In other cases the engineering design may require high quality of material because high working strains per unit section are to be imposed upon the finished casting. In such cases engineering attention should be paid to the size of the test specimen which is to furnish an index of quality, and to the relation which exists between the strength of cast-iron when cast into light test pieces, and that of the same metal when cast into heavy sections.

The writer has taken specimens from an iron casting having at one point in the casting tensile strength as high as 30 250 lbs. per square inch, and as low as 20 502 lbs. per square inch in another and heavier section. The difference in this was wholly related to the thickness of the section and to the rate or speed of cooling, with its consequent effect upon the grain and upon the strength of the iron of which the casting was composed. It might be said that large sections cannot be cast to yield the high strength that is sometimes associated in engineering minds with specimen test pieces cast in smaller sections of prevailing sizes.

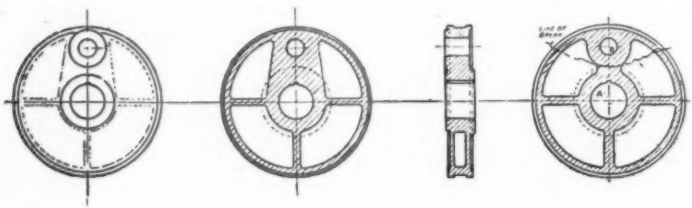


FIG. 1.—CRANK ILLUSTRATION.

It is well that the foundryman be acquainted to some extent with the engineering purposes for which these castings are intended. This knowledge will enable him to pay particular attention to such points or parts of the casting as are specially critical, and to such as are to be machine-finished. He can usually arrange to place his chaplets, anchors, and core vents so as to keep them clear of the working or sliding machined surfaces, and he can then better provide for producing a casting which is a clean one at these critical points. The moulder, if left to himself, may, and probably will, put chaplets and anchors directly in the path of a machined slide, unless someone who knows better sees him and prevents it. Sometimes this kind of information

would seem to be obvious, but often it is not so, and a hollow cylindrical casting with flanges on each end might, for all the moulder knows, be a pipe having no special requirements, whereas it was intended to be a cylinder, which must be bored, faced, and generally machined, and must be perfectly free from defects, and a casting in which chaplets and anchors are utterly inadmissible.

Certain points or spots on a large casting may require to be drilled and tapped, and may demand a high quality at that spot. A suitably located chill will insure soundness and solidity here if the foundryman knows what is demanded; if he does not know, the casting is made, looks good to him, is shipped out, and when machined is found to be hollow, cavitated or spongy at the critical spot.

In ordinary cases, designs for castings should be such that it will not be necessary for the foundryman to pay particular and extraordinary attention to special or heat treatment, because in the press of other matters such treatment may occasionally be forgotten and omitted, or it may be imperfectly done by inexperienced men. A casting is best designed if it can be uncovered promptly after pouring, lifted out of its bed, and deposited on the floor of the chipping shop. This is what is done with 95 per cent. of the output of the average foundry, and it is what the workmen are accustomed to. Special cases soon become irksome, and someone will, perhaps, assume the responsibility of saying: "This special treatment is all foolishness, and the casting is just as good without it." There are, however, cases in which it is necessary to design castings that do demand this special treatment.

Fig. 1 is a sketch of a peculiar crank disc which was made in an iron-foundry under the author's management some five or six years ago.

The first casting was poured in the usual and ordinary manner, and after a decent delay in the flask was uncovered and removed to the chipping shop. It lay on the floor of the latter department for a day or two after cleaning; it was then shipped to the machine shop, which is located about twelve miles away. When the casting arrived at the machine shop it was found that it had been so stressed by internal strains that a large piece had not only broken away from the balance of the casting, but it had jumped clear off the railway car on which it was being conveyed, and the missing piece was found by a track walker alongside of the railway track a few hours after its loss was reported. The line of breakage is indicated on the sketch, and the missing piece weighed perhaps 1½ to 2 tons. This case was studied carefully; the heavier interior member, being the last of the casting to cool, had set up the violent internal strains which caused the casting to rupture.

We arranged the next casting so that a few minutes after pouring had been done a small stream of water in a regulated quantity was caused to drop into the hollow cores *A* and *B*, as shown on the sketch, compelling the hubs surrounding these cores to cool in advance of their natural time, and at least approximate synchronous cooling with the balance of the casting. The other portions of the casting during this period were kept muffled up in the sand and their cooling was delayed, while the cooling of the crank hubs was accelerated. After this method was adopted twelve such castings were made, all good, and they have been in service for some years.

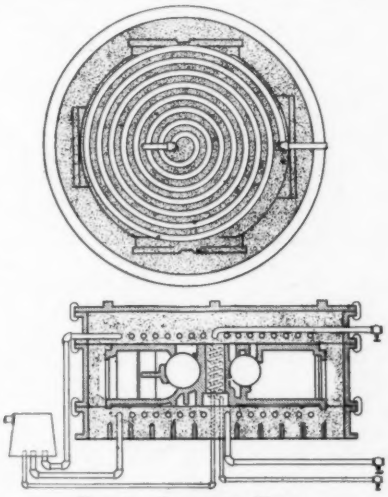


FIG. 2.—CYLINDER HEAD.

Cooling Treatment for Special Cases.

The writer had to produce a number of large cylinder heads for Corliss engines, these heads having ports for steam and exhaust valves formed in the

heads. Structurally considered, these heads were like a cylindrical steam drum of large diameter, but of very short length, having a flat head at each end, and were required to stand internal pressure.

Considering the resistance to internal pressure, the cylindrical shell or outer wall could be designed quite thin, as the strains in it were all tensile strains, while the heads, being flat and of great area, were subject to bending strains which demanded that these be greatly thickened up to make the flat surfaces, not easily stayed or braced together, strong enough to carry safely the pressure. In addition to this greater thickness of flat head, allowance had to be made for a machine-finish on the flat surface, which was not required by the shell, and the disparity thus became still

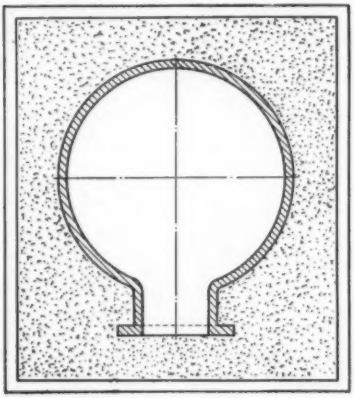


FIG. 3.

greater. The port openings for the admission and exhaust of steam made large holes in this head or flat plate, which were to be tied across ports by bars or ribs. In cooling by natural processes these bars almost invariably cracked in the casting, because the cylindrical shell being thin, cooled first, and was assisted in doing so by its position, which was very close to the sides of the flask, where radiation was active. The flat head, on the contrary, was at the bottom of the flask, where radiation was poorer, and it was practically twice as thick as the rim, and cooled more than twice as slowly. With these divergent tendencies in the casing troubles ensued. The rim cooled early, and took on its final dimensions and in the form of a circle opposed to compression—the strongest possible shape. The head, or plate, or diaphragm, cooling later, had its contraction tendency resisted by the stiff rim and a struggle was set up. The tension member was, of course, the weaker, and the large openings in the latter made the result a foregone conclusion—the diaphragm simply had to shrink or be stretched, the rim would not give—the ribs broke.

We cured this trouble by the following means:—In the drag portion of the mould we placed a spiral coil of iron pipe through which we could circulate cooling water. This coil was placed as close to the face of the pattern as was considered safe, about 1½ in. away. The inner cores by which the head was hollowed out were also provided with similar interior cooling coils, and the cope had a coil like that of the drag. After the casting was poured we waited for a few minutes to enable solidification to begin, and then we turned water into these cooling coils, and connecting the overflow to sewer connection, let the water run all night. The casting lay in the mould, the rim kept muffled in sand to delay cooling, while the coils close to the heads accelerated cooling. The result was most satisfactory, and the castings produced by this process have stood the severest tests of several years' continuous duty without failure. Heads of similar design made by other foundries cracked systematically, sometimes while the casting was still in the foundry, sometimes in the machine shop, but quite frequently not until after the engines were put into operation. In all cases the stress was there, and the only question was, when would it cause breakage. See Fig. 2.

Shapes.

It might seem almost unnecessary to say that shapes of sections, flanges and other projections should be so designed that the moulder may most easily produce the desired shape without having to use complicated means. If the designer or draughtsman were a man who had a little practical experience in foundry work he would see numerous opportunities for making shapes that would "draw" easily, rather than certain other shapes that look well on paper but are much harder to produce. Of course, the foundryman can produce almost any conceivable shape if he has to, but engineering design is at its best when its shapes are at once

suitable for the intended purpose and easily and cheaply produced. On work of considerable size a little more time required to deal with a detail may prevent doing any pouring to-day, with a strong probability that the moulder can make that job last him "until to-morrow night." The designer should try to put himself in the moulder's place and imagine himself making the mould in question. Then he will see what a small difference in design sometimes causes a big difference in cost and risk. An instance of this is Fig. 3, and represents a prospective nozzle with a flange for steam or water connection.

If the flange in Fig. 3 is at the bottom of a complicated casting it will require the flange pattern to be cut into removable sections

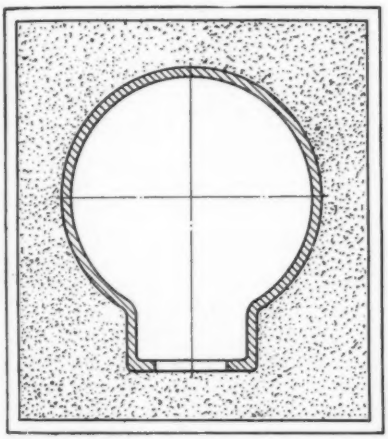


FIG. 4.

or a troublesome embedded core is required. If practicable to design as in Fig. 4, the neck draws naturally, and the main core forms the flange. This sort of change may not always be possible, as certain designs will demand loose bolts, while Fig. 4 would call for stud bolts, but there are cases in which the foundry's troubles can be reduced in this manner.

It is not supposed that the foregoing is in any sense exhaustive, and it is presented with the idea chiefly of calling more attention than is usually given to the relation which exists between good design and good foundry practice, and to some of the physical phenomena connected with the manufacture of large and complicated shapes in iron castings.

Breakages are sometimes difficult to account for, and the designer may think the fault is with the quality of the iron, which has nothing at all to do with the trouble, and when the shape and design are the true cause. The "physics of the foundry" were not properly understood when the design was made.

If this paper can have the effect of making the designers of cast-iron structures "sit up and take notice" of the foundry's physical problems, even a little bit, it will have accomplished the purpose of its author.

——o——

SIR HUGH BELL, BART., has decided to retire altogether from municipal life.

THE announcement has been made that the well-known marine engineering firm of Humphrys, Tennant & Company, of Deptford Pier, have decided to close their works permanently when they have completed contracts in hand.

MOUNTFORD, PHILLIPS & COMPANY, LIMITED, of the Thorns Chain, Cable, and Anchor Works, Brierley Hill, Staffordshire, have removed their head offices from Brierley Hill to their Cambrian Tram and Engineering Works, Llantrisant, Glamorganshire.

THE amalgamation is announced of the engineering firms of Applebys, Limited, and the Temperley Transporter Company. The combined firms will trade under the title of Applebys, Limited, with offices at 58, Victoria Street, Westminster, London, S.W., and works at Glasgow and Leicester.

NEW ZINC SMELTING METHOD.—The majority of shares in the Company, which has been formed in order to exploit Dr. de Laval's new zinc smelting method, have now been bought in Sweden. According to his method the cost of zinc smelting will be about half of what it is now, and it is possible that there will be a revolution in zinc production. From the central Company, the Laval Zinc Company, in Stockholm, there will be formed a series of branch Companies in Norway, Russia, England, Australia, Canada, Mexico, West Indies, Spain, Sicily, Rhodesia, Japan, etc. The first negotiations in England are to be opened in some few weeks.

PATTERNS FOR REPETITION WORK.*

By E. H. Berry.

A pattern which is run continuously for months, or perhaps years, clearly falls within the limits of this paper as being used for repetition work. And it is just as clear that one which is discarded after a single casting has been made from it should be classed as a pattern for jobbing work.

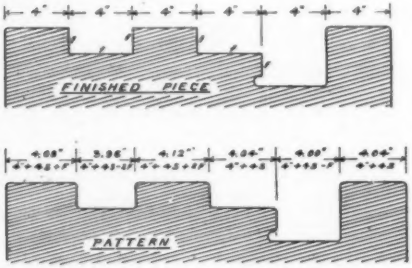


Fig. 1.—Allowances for Shrink and Finish.

The exact point which marks the division between them depends, in a large measure, upon the size of the foundry and the kind of work it handles, and the two classes frequently merge into each other by imperceptible gradations. Without attempting to fix specific limits, we can use the extreme cases cited above to indicate the lines along which the distinction should be drawn, leaving each pattern user to decide for himself as to the precise position on the scale which he assigns to any given pattern.

It is this position which usually determines the expenditure that can be permitted in making the pattern, for it is evident that a cost which would be perfectly legitimate for making say a million castings, might be excessive if only ten thousand were required, and entirely prohibitive for one thousand. On the other hand, the circumstances might be such as to justify a high pattern cost, even for a small number of castings, as for instance, in the case of certain master patterns, further reference to which will be made elsewhere in this article.

Fig. 2.—"Plate" Pattern.

Many of the conclusions reached in this paper may be borne in mind to good advantage, even in the case of jobbing patterns. But the very nature of the service for which these are intended is such that the designer must leave most of the details to the judgment of the pattern-maker; and if the latter fails to catch every important point, it simply means that the moulder may have to spend some additional time in producing the desired casting from the pattern furnished him. For whatever use the pattern is intended, the problem resolves itself into a question of distributing the total work in such a way as to attain the greatest economy in the final result.

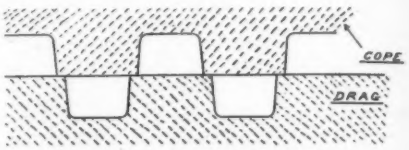


Fig. 3.—Castings Staggered in Drag and Cope.

Actual observation of the practical working of different methods of producing patterns has convinced the writer that no pattern which can be legitimately classed as being used for repetition work should ever be made except from a drawing which looks like the pattern, and gives the actual dimensions of the pattern itself. Mention is made of the fact that the drawing should look like the pattern, for the reason that, on small work, the allowances for shrinkage, finish and draft, may make the appearance of the pattern quite different from that of the finished piece.

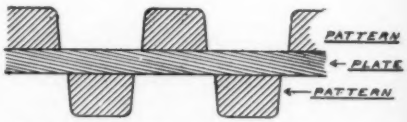


Fig. 4.—"Staggered Plate" Pattern.

In making patterns for repetition work, micrometer calipers, vernier cali-

* Presented at the New York meeting of the American Society of Mechanical Engineers.

pers, height gauges, etc., are constantly called into requisition, and as it would be both expensive and confusing to attempt to duplicate these in different shrinkage scales, it becomes necessary to work to figures which include the necessary allowances for shrinkage. To the man who is accustomed to big work on which a quarter of an inch is close, and a thirty-second is the very height of refinement, it may seem absurd to use thousandths in measuring patterns. But there are many cases in repetition work where this degree of accuracy is not only desirable but absolutely essential.

As an example of the effects of shrinkage and finish, let us assume that we

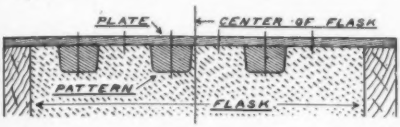


FIG. 5.—"REVERSIBLE PLATE" PATTERN.

wish to produce the piece shown in the upper part of Fig. 1, the marks *f* indicating finished surfaces.

The lower part of Fig. 1 shows the actual pattern dimensions, assuming,

Shrinkage per inch of length, $S = 0.01$ inch
Allowance for finish, $F = 0.04$ inch

In this particular case, the various combinations of shrinkage and finish modify the final 4-in. dimensions, so as to produce dimensions of 3.96 in., 4.00 in., 4.04 in., 4.08 in. and 4.12 in. on the pattern.

In actual practice the dimensions would not usually be strung out in one continuous line as in Fig. 1, but would probably double back on themselves to some extent. In addition, the shape of the casting might be such as to make the shrinkage irregular; it might be

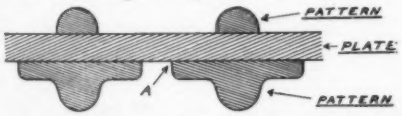


FIG. 6.—"PLATE" PATTERN WITH PORTIONS OF PATTERN ON EACH SIDE OF PLATE.

desirable to allow more finish at certain surfaces than at others, and it might be necessary to make additional allowances for draft.

In view of all the factors to be considered, the determination of the pattern dimensions by a process of mental arithmetic may be an excellent athletic exercise for the brain, but it is not a problem which a mechanic should be called upon to solve during working hours.

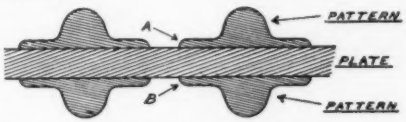


FIG. 7.—"PLATE" PATTERN CALLING FOR ACCURATE MATCHING OF DRAG AND COPE.

It is also necessary to remember that very few machinists or tool-makers have much detailed knowledge of foundry practice, and that the trade of metal pattern-making is still comparatively new. Patterns made and carded according to the best judgment of a tool-maker have often been entirely rebuilt after the first attempt to run them in the foundry. Of course, such occurrences indicate lack of co-operation, but the only practical way to secure effective co-operation is to prepare a drawing which records the decision reached after due consideration by all the interested parties.

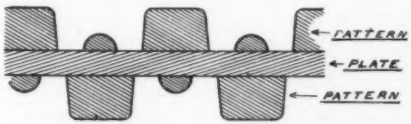


FIG. 8.—"STAGGERED PLATE" PATTERN WITH PORTIONS OF PATTERN ON EACH SIDE OF PLATE.

There is no doubt but that the best and most economical results are obtained by using men who are skilled in working accurately to drawings, and then supplying them with drawings which they can follow absolutely. Even if it were possible for the workman to carry in his head the various allowances required on a pattern, the lack of a record covering them would lead to endless trouble and confusion. If a pattern has to be duplicated or replaced, the worn one must either be copied as closely as possible, or the workman, who may or may not be the author of the original pattern, must introduce a new set of allowances. And while it sounds simple to tell a man to "make another just like this," we all know how the little errors accumulate until the final result is startlingly different from the original.

It is said that a Chinaman can and will copy a model with absolute fidelity, but no one has ever had the hardihood to make a like assertion in regard to a workman of any other nationality.

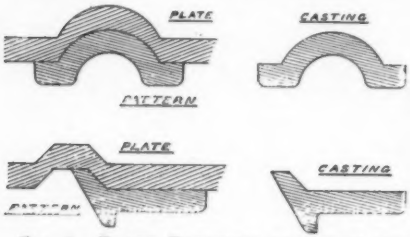


FIG. 9.—PLATE PATTERNS IN WHICH THE PARTING SURFACES ARE NOT PLANE.

For computing shrinkages, the drawing room should be furnished with a table giving the shrinkage per inch (in hundredths or thousandths of an inch) for each of the materials commonly used. This shrinkage, multiplied by the length in inches of any part of the casting, gives the allowance in inches direct. It may seem superfluous to explain this apparently self-evident procedure, but the author has seen cases in which the shrinkage was expressed in fractions of an inch per foot of length, and in which each dimension was carefully translated into decimals of a foot before multiplying by the constant.

FIG. 10.—CLEARANCE AT UNIMPORTANT PORTIONS OF PARTING SURFACE.

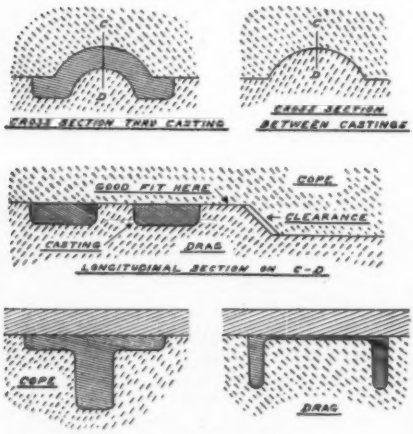


FIG. 11.—"SPLIT" PATTERN.

It will frequently happen that there are certain parts of a casting where a high degree of accuracy is not necessary, and a very little time spent by the drawing room in determining and indicating these points will be amply repaid by the saving in making the patterns. The required degree of accuracy can best be indicated by means of the number of decimal places in the figure giving the dimension. In using this method there must be an understanding between the drawing room and pattern-maker that the permissible error is never greater than one in the last decimal place. For instance,

1.127 indicates a permissible error of 0.001 inch ±
1.120 indicates a permissible error of 0.001 inch ±
1.12 indicates a permissible error of 0.01 inch ±
1.10 indicates a permissible error of 0.01 inch ±

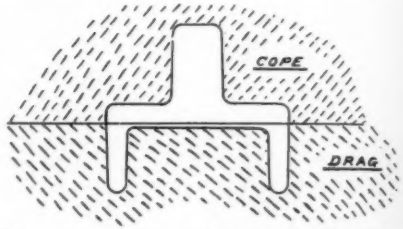


FIG. 12.—MOULD MADE FROM "SPLIT" PATTERN.

Reference to the Figs. 2 to 14, illustrating the various methods of carding, and to Figs. 15 to 25 illustrating the location of the parting line, will show that many different arrangements for draft are possible, although only one may be desirable. The pattern drawing should, therefore, show where the parting comes, and should indicate the amount of draft to be allowed at different points. The allowances for draft are discussed in detail under a separate heading.

A carding drawing should be prepared in conjunction with the drawing of the pattern itself. These must be carried along together, as a change in one will usually affect the other. The carding drawing should show clearly the arrangement of the runner, the enlarged portion of the runner where the sprue is to be cut, the location and size of the gates, the points at which they join the patterns, the arrangement of the patterns, the location and size of risers or shrink balls, if used, and the connections, if any, which may be needed in addition to the gates for supporting the patterns. It may really be looked upon as an

assembly drawing, and will usually require only a few dimensions.

To avoid the confusion which might arise if carding drawings sometimes show the drag side and sometimes the cope side, it is well to adopt the rule of showing all cardings as they would appear when looking at the drag side. In the case of an "open" carding, this rule causes the pattern to be shown as it appears when looking down on it as it lies on its mould board.

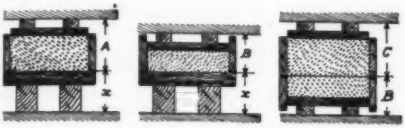


FIG. 13.—HEIGHT OF MOULD BOARD.

Turning now from the general requirements, we may, for convenience, group under the following headings those details which involve a consideration of the peculiarities of each individual case :—

A The number of patterns to be grouped in one card and the size of the flask.

B The method of carding, whether mounted on a "plate" or as a "split" pattern, or "open" for use with a mould board, etc.

C Location of the parting line.

D Allowances for draft.

E Arrangement of the gates, runners, risers and supporting connections.

F The material of the pattern, and of the runner, plate, mould board, etc.

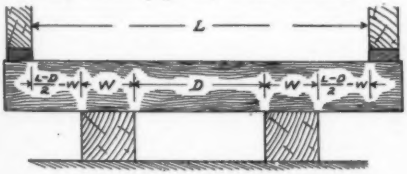


FIG. 14.—SPACING OF CLEATS.

G The points on the pattern at which special accuracy is required.

H The amount of work to be expended on the pattern.

These in turn depend on the given conditions which may be tabulated as follows :—

a The size and shape of the casting.

b The special requirements, if any, which may call for placing the pattern in a certain position or for providing risers, shrink balls, etc., in order to secure sound castings.

c The machining operations to be performed on the casting.

d The locating points for these operations.

e The points at which fillets and rounds are required.

f The degree of accuracy needed at unmachined portions and points, if any, where special accuracy is required.

g The rate at which the castings are to be produced.

h The probable total number required.

i The probable length of the intervals during which the pattern is out of use, and the conditions under which it is stored during these intervals.

Having determined the considerations affecting the design and construction, we may consider them in detail.

The Number of Patterns to be Grouped in one Card, and the Size of the Flask.

For snap flask work it is usually necessary to allow a wall of sand about 1 in.

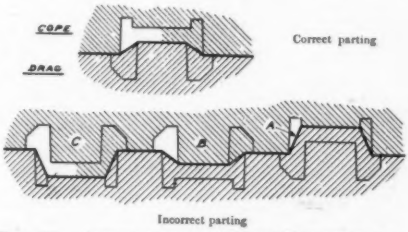


FIG. 15.—AVOIDANCE OF STEEP INCLINES IN PARTING SURFACE AND OF HANGING POCKETS OF SAND.

thick outside of the extreme points of the patterns. If the card consists of a number of small patterns, the walls of sand between them tie into the outer wall and help to support it. Under these conditions, no further support is necessary for castings extending say $\frac{1}{2}$ in. or less above or below the parting line. If the castings are deeper, or if there is a considerable length of outer wall which is not supported by other walls tying into it, a band may have to be provided, but the 1-in. dimension may still be maintained. In most cases the work of handling the band is less than the work of handling the increased amount of sand required by a larger mould. Even if iron flasks are used, the 1-in. dimension should generally be adhered to, as there is apt

to be trouble in ramming and danger of the flask acting as a chill if the outer wall of sand is reduced much below that figure.

Unfortunately, the manufacturers of foundry supplies seem to have made no attempt whatever to select certain sizes of flasks which can be looked upon as standard, and therefore given the preference whenever circumstances permit. Their catalogues usually state that they will make any size of flask desired, but this does not help the man who is endeavouring to standardise his equipment.

Special sizes can never be entirely avoided, but the author recommends the general adoption of two sizes which have proved very convenient for small snap flask work. The smaller of these, 9 by 16 in., inside measurement, is the best all round flask for work within its range. The larger one, 10 by 18 in., inside measurement, is nearly as convenient, and there is no serious objection to its use, provided it permits of a more advantageous grouping for a given pattern. There is, however, a limit beyond which the increased weight of each mould more than offsets the advantage secured by the reduction in the number of moulds. Experience shows that the output with a mould 9 by 16 in. is just about equal to the output with a mould 10 by 18 in. holding one-third more castings. Whether or not the larger flask will increase the capacity more or less than this amount can be determined only by laying out the possible groupings for each size.

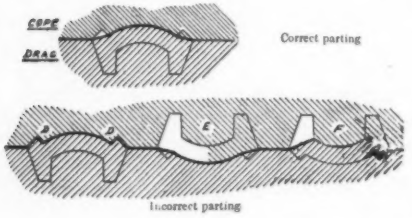


FIG. 16.—AVOIDANCE OF UNSUPPORTED PROJECTIONS OF SAND AND OF HANGING POCKETS OF SAND.

Whenever there is a choice between any two sizes and their outputs are practically equal, the preference naturally rests with the smaller one as involving the smaller expense for patterns, flasks, etc.

In fixing the length and width of a flask, the designer has usually some latitude, as he can vary the grouping of his patterns, but the depths of the drag and cope are less under his control. As the sand in the drag is never called upon to support its own weight, the depth of the drag need never be greater than is necessary to provide sufficient sand (say 1½ in. after ramming or squeezing) below the deepest portion of the pattern. The depth of the cope must be sufficient to give a corresponding amount of sand above the pattern, and it must also be sufficient to make sure that the sand will support its own weight when the cope is lifted. The depth of the cope will sometimes be fixed by one and sometimes by the other of these requirements.

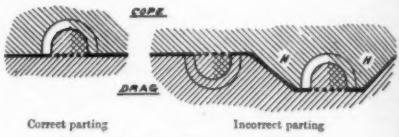


FIG. 17.—CASTING IN COPE.

If the ramming is done by hand, the mould is struck off flush with the flask, and the depth of the latter corresponds with the desired depth of the mould. If the mould is squeezed by power, the flask must be deeper than the desired depth of the mould by an amount equal to the squeeze. The squeeze may be figured as about four-tenths of the original average depth of loosely packed sand.

If the pattern is mounted in a frame, the depth of the drag-half of the flask must be further corrected by deducting an amount equal to the thickness of the frame. The frame should always be considered as belonging to the drag-half of the flask.

The following table gives the minimum depth of flask which experience has shown to be permissible for a cope, squeezed by power, in order that the sand may support its own weight :—

TABLE 1.—*Minimum Depth of Flask.*

Size of flask in inside measurements.	Minimum depth of flask giving a cope that can be lifted.	Approximate depth of cope half of mould.
Inches.	Inches.	Inches.
9 by 16	3	1¾
10 by 18	3½	2
12½ by 17½	3¾	2¼
13½ by 15½	3½	2¼
14 by 23	4	2½

If the conditions require a deep flask, or one which is larger than either of the two sizes mentioned, care should be taken whenever possible to avoid moulds beyond the capacity of a single operator.

For snap flask work the limits for a one-man mould are about as follows :—

A Width 12 in. inside of flask. A greater width makes the mould liable to tip toward or from the operator.

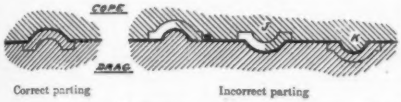


FIG. 18. — CASTING PARTIALLY IN DRAG AND PARTIALLY IN COPE.

B Length 24 in. inside of flask. A greater length requires an excessive spread of the arms.

C Weight 85 lbs. corresponding roughly, for flasks of average depth, to an internal flask area of 250 square in.

Care should be exercised to avoid moulds which are square or nearly square, as they are liable to tip, even if the width is less than the 12 in. specified above. The best shape is obtained when the width is from $\frac{5}{10}$ to $\frac{6}{10}$ of the length.

When carrying a mould supported by a solid flask the operator can rest it against his body, whereas a mould from which the flask has been removed must be swung free from all danger of contact. For this reason solid flasks may be somewhat larger than snap flasks, in spite of the fact that the flask itself has to be handled in addition to the mould. The permissible increase may be taken at about 10 per cent. in length, 30 per cent. in width, and 50 per cent. in weight.

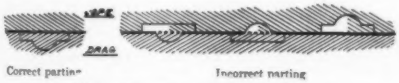


FIG. 19.—CASTING IN DRAG.

Although output is an important consideration, we must not lose sight of the fact that it is not the sole determining factor in selecting a flask size. If the required rate of production is low and the probable total requirements small, it may pay better to mount a few patterns on a small card in preference to carding even a considerably increased number for a slightly larger flask. Further reference to this will be made under heading "The Amount of Work to be Expended on the Pattern."

Every possible care should be exercised to limit the number of different sizes of flasks. A record should be kept of all existing sizes, and no new size should be created unless it is perfectly certain that none of the old ones are suitable.

It will nearly always be a safe rule to use a plate whenever the pattern permits. It gives the most durable construction, and except in special cases, such as those shown in Figs. 5 and 11, it permits of making both halves of the mould at once. The simplest case arises when one side of the pattern is flat, permitting it to be mounted as shown in Fig. 2.

If, instead of being shallow, the pattern is deep, a considerable space must be left between adjoining patterns to give a sufficient wall of sand. In such a case a saving can be effected by putting

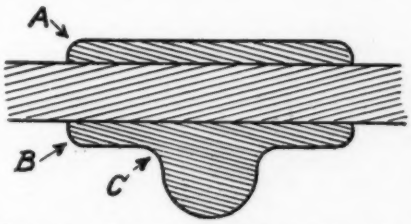


FIG. 20. — PLATE PATTERNS WITH ALL CORNERS ROUNDED.

the patterns alternately above and below the parting line as in Fig. 3. This can be arranged in two ways; by actually mounting patterns on both sides of the plate, as in Fig. 4, or by making only half the number of patterns and mounting them on one side as shown in Fig. 5.

It is evident that if the first half mould made is used as the drag and the next one turned over and placed on it as the cope, the desired staggering will be obtained. This style of plate is sometimes known as a "reversible plate," although, strictly speaking, it is the mould and not the plate that is reversible.

The first method gives the greater output, as both halves of the mould may be made at once. It is to be preferred for shallow patterns of simple form, as it obviates the necessity for special accuracy in locating the patterns and keeping flask pins true. If the pattern is complicated, a decided saving in pattern cost can be effected by using the second method. If the pattern involves a deep

draw, the second method is again to be preferred, as it requires only the lifting of the pattern from the sand, and not the lifting of the cope off of the pattern. The "reversible" method has the disadvantage which may in some cases prove serious, of producing half the castings under one set of gating and cooling conditions and half under another set. This is referred to in further detail.

Careful work to make the two sides of the plate match, and to keep the flask

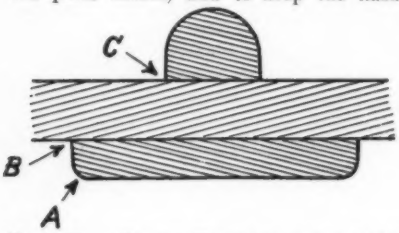


FIG. 21. — PLATE PATTERN WITH SOME CORNERS LEFT SQUARE.

pins true is necessary if portions of the pattern have to be mounted on opposite sides of the plate. If a square corner is permissible at *A*, they may be mounted as in Fig. 6. If a round corner is required at both *A* and *B*, they must be mounted as in Fig. 7. The staggered arrangement can also be used for patterns extending on both sides of the parting line as in Fig. 8.

In order that the two halves of the mould may meet properly the vertical distance between the upper and lower faces of the plate must be constant throughout, excepting at certain points where an excess thickness is purposely provided, as referred to later. This condition can be easily met if the parting surface is a plane, but prohibits the use of a plate if this surface assumes a complicated shape. If the surface can be given some simple geometrical form which can be easily machined, a plate can often be used to good advantage even if the parting is not in a single plane. Several cases of this kind are illustrated in Fig. 9.

In making such plates, the best results will be obtained if a little extra thickness is given to the plate at any points where an exact fit of the mould is not required. For example, in the first of the patterns shown in Fig. 9, the different sections through the moulds should appear as shown in Fig. 10.

The "split" pattern is really a modification of the pattern shown in Fig. 6, 7, and 8, which is used if the draw is so deep that the cope can not well be lifted off of the pattern. In such a case the pattern is split, each half being separately mounted as in Fig. 11. The pattern is lifted from the drag and also from the cope, and the latter is turned over and set on the drag, making the completed mould appear as in Fig. 12. If used with a stripping plate the principle is the same, only the patterns are reversed and drawn downward through the plate, instead of being lifted up. If the casting happens to be symmetrical about the parting line, a single pattern can be used for both the drag and cope.

If the parting surface is too irregular for a plate the ordinary pattern connected to a runner and provided with additional supports, if necessary, must be used, so as to make an "open" carding. As this construction gives no backing to the pattern, a separate support must be provided in the form of a mould board. The use of the mould board makes it impossible to ram up both halves of the pattern at once. If power squeezers are used with this style of pattern, special care must be taken to give the drag a heavy squeeze and the cope a light one. If this precaution is not observed the pattern will be sprung, and pressed still further into the drag half, when the cope is squeezed. When ramming by hand there is less danger of springing, as the support afforded by the drag has to resist only the localised blow of the hammer instead of a pressure exerted simultaneously over the entire parting surface.

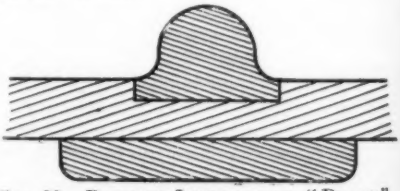


FIG. 22.—PATTERN INSERTED IN "PLATE" TO PROVIDE GOOD FILLETS.

If the moulds are squeezed by power, it is desirable to put cleats under the mould board so that the total height will be such as to keep the idle portion of the stroke as small as possible at all times.

From Fig. 13

$$A + x = B + C.$$

it follows that

Desired height of mould board,

$$x = B + C - A$$
$$= C - (A - B)$$

where C is the combined height of cope and squeezing board before squeezing, and $A - B$ is the amount of squeeze in the drag.

Locating the cleats so as to reduce the deflection of the mould board to a minimum is a matter which deserves attention, particularly in the case of long flasks. It may be assumed that the pressure exerted on the mould board through the sand is practically uniform at all points, and the mould board may

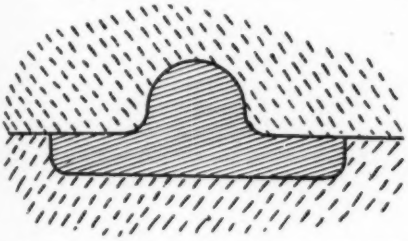


FIG. 23.—FILLETS IN "OPEN" CARDED PATTERNS.

therefore be treated as a girder, resting on two supports and uniformly loaded as shown in Fig. 14.

For a pressure of P pounds per inch of length, the deflections may be represented as follows:—

Deflection at ends of mould =

$$\frac{P\left(\frac{L-D}{2} - W\right)\left(\frac{L-D}{2} - W\right)^3}{8 \qquad E\,I}$$

Deflection at centre of mould = $\frac{P\,D}{384} \cdot \frac{D^3}{E\,I}$

Placing these equal to each other, and solving we get

$$D = \frac{\sqrt[4]{3}}{\sqrt[4]{3} + 1}\ (L - 2\,W)$$

$$D = 0.568\ \ (L - 2\,W)$$

The cleats on the bottom boards and squeezing boards should be centred with the cleats on the mould boards. The thickness of the squeezing board and of the bottom board, including the cleats in both cases, must be greater than the distance travelled in squeezing. The middle view in Fig. 13 will make this clear.

Location of the Parting Line.

The location of the parting line, both with reference to the pattern itself, and with reference to the edges of the flask, is highly important, and the judgment used in its selection may make the whole difference between success and failure in producing the moulds.

In locating it we should be governed by these rules:—

A. Avoid steep inclines in the abutting surfaces of the drag and cope. Always keep these surfaces as nearly square to the line of lift as possible.

B. Avoid unsupported projections of sand, particularly in the cope. Avoid hanging pockets of sand in the cope.

C. Make the draw in lifting the cope as small as possible.

D. Where a draw in the cope is unavoidable, endeavour to keep it up within the flask so that the latter will support it.

E. When practicable, avoid a parting surface which intersects a face of the casting. Give the preference to a parting which forms a continuation of a face even if a rounded corner has to be sacrificed.

F. If a mould board is used, avoid exposed joints between it and the pattern.

Following these rules the first of the partings shown in Figs. 15 to 19 inclusive are the ones to be preferred in each case. Partings similar to those shown in Figs. 20 to 24 inclusive should be used only if necessary, and of the two partings shown in Fig. 25 the first is to be preferred.

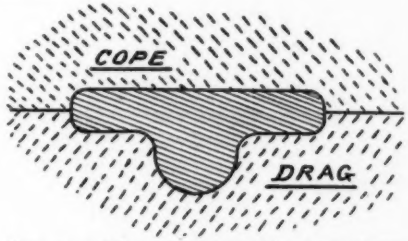


FIG 24.—"OPEN" CARDED PATTERN WITH ALL CORNERS ROUNDED.

Fig. 15 illustrates the avoidance of the steep incline at A and of the hanging pockets of sand at B and C. Fig. 16 illustrates the avoidance of the unsupported projections of sand at D and of the hanging pocket of sand at E and F. Figs. 17 and 18 illustrate again the avoidance of hanging pockets of sand at G, H, J and K, and Figs. 15 to 19 inclusive illustrate the features of keeping the draw in the cope as small as possible, and of keeping it up inside of the flask.

It is interesting to note that the application of these rules results, in different cases, in locating the casting in each of the three possible positions in the mould, namely: entirely within the cope, as in Fig. 17; partially in the cope and partially in the drag, as in Fig. 18; and entirely in the drag, as in Fig. 19.

Fillets and rounded corners are such excellent things—in their proper places—

FIG. 25.—PATTERNS LET INTO MOULD BOARD.

and their importance has been written about and talked of so much, that we are sometimes led into calling for them in places where they are of no help to the casting, and really become very objectionable on the pattern.

For instance in the very simple pattern shown in Fig. 2. If it were absolutely necessary to round all the corners it would have to be mounted as shown in Fig. 20, adding extra expense to the making of the pattern, and making it necessary to exercise constant vigilance to keep the flask pins true.

If it were permissible for the corners *B* and *C* of Figs. 20 and 21 to be square, the pattern might be mounted as shown in Fig. 21. This would still permit of a round at *A*. If a fillet were required at *C* of Fig. 21, it would run out to a feather edge at the upper surface of the plate, and if a smooth and true surface

FIG. 26.—NICKED GATE.

were required at that point of the casting, the pattern would have to be set into the plate as in Fig. 22. The objection to this fillet applies only to "plate" patterns and not to "open" cardings. If carded "open," the mould and pattern would appear as in Fig. 23. The objection to the double rounded corners, however, holds for the "open" carding as well as for the plate, as the cope, instead of being flat, would have to be brought down as shown in Fig. 24.

Whenever a rounded corner involves the shifting of the parting line from its best position, an effort should always be made to modify the design so as to permit of a square corner at that point. If the trouble is feared from the chilling of the corner it is well to remember that in hand-moulding this chilling is more frequently due to wetting the mould than to the actual sharpness of the corner. In machine moulding, using well-made patterns with ample draft, there should be no occasion whatever for wetting the edges of the mould.

In avoiding objectionable projections or hanging pockets of sand, it will be of

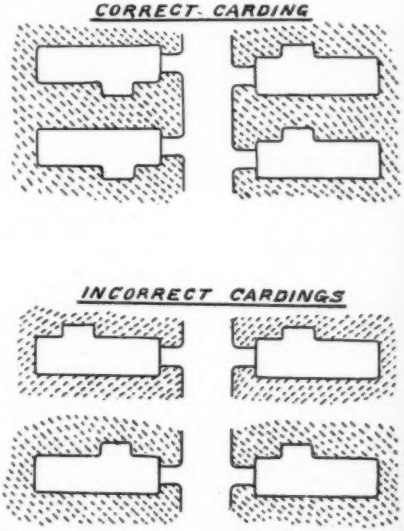


FIG. 27.—EFFECT OF CARDING ON UNIFORMITY OF CASTINGS.

assistance to bear in mind that the mould board corresponds exactly to the cope, and that all irregularities in one will be reproduced in the other. It is therefore always desirable to keep the mould board as free from such irregularities as may be consistent with the other requirements which have to be met.

In the case of the pattern shown in Fig. 25, it makes little difference, as regards the draw, which side is put in the cope. But of the two positions shown the first is to be preferred, as it avoids the exposed joint at *D*. Such a joint requires careful fitting when the mould board is made, and frequent repairs are necessary to maintain its accu-

racy. By placing the pattern in the first position it covers the recess in the mould board entirely. In this case the recess merely becomes a clearance opening, and no fit is necessary, except perhaps at the bottom, in order to support the pattern and to prevent it from

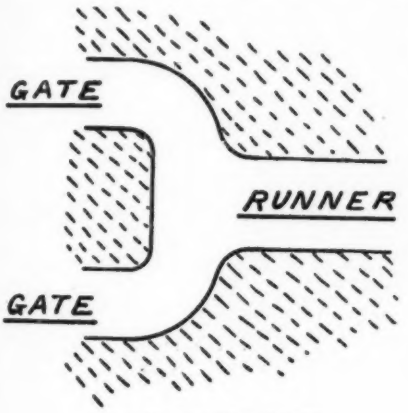


FIG. 28.—OFFSET GATES.

springing. The first position has the further advantage of requiring the removal of less material from the board. The carving of a mould board is a tedious and expensive hand operation at the best, and every method of reducing this expense is well worth considering.

In the foregoing we have considered moulding conditions but not casting conditions. A description of the latter would be beyond the scope of this paper, but attention is called to the fact that they may at times necessitate a departure from the arrangement which would be the most desirable if only the making of the mould had to be reckoned with.

Allowances for Draft.

It is necessary that draft toward the parting line be provided in all cases. A smaller draft is permissible when the pattern is lifted from the sand, as in the case of "reversible plate" patterns, "split" patterns, and the drag side of all other patterns, than when the mould is lifted off of the pattern, as in the cope-half of all except "reversible plate" patterns and "split" patterns.

If the draw is shallow it is usually desirable to express the draft in degrees, but if the draw is deep it is better to give dimensions for the top and bottom of the taper. In the first case a slight error in measuring the angle would not sensibly affect the dimensions of the piece, while a slight error in the dimensions might change the draft very considerably. In the second case the conditions are exactly reversed.

For those portions of a pattern which are drawn from the sand, the draft should never be less than 1 degree on a side, or 0.02 in. per inch, on a side. If possible, it should be about 2 degrees on a side or 0.03 in. to 0.04 in. per inch on a side.

For those portions of a pattern from which the cope has to be lifted, the draft should never be less than 1½ degrees on a side, or 0.03 in. per inch on a side. If possible, it should be about 3 degrees on a side, or 0.05 in. per inch on a side.

Arrangement of the Gates, Runners, Risers, and Supporting Connections.

If any portions of the desired casting are very heavy, in comparison with the remaining portions, the gates should be arranged to feed into the heavy parts. The gates should usually be wide and thin so as to break off easily. If the casting is very light it may be necessary in addition to nick the gate. Care should be taken to leave a good fillet between the nick and the casting itself as shown in Fig. 26 in order to give a clean break at the nick.

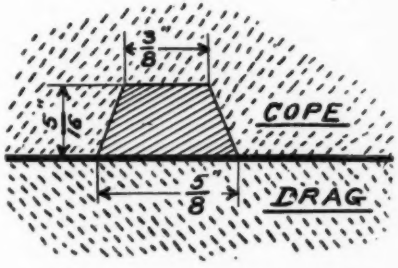


FIG. 29.—CROSS SECTION OF RUNNER.

To secure uniformity among the castings from any one card, it is desirable to card them all alike, as shown in the upper part of Fig. 27, and not half right and half left, or half at one end and half at the other, as shown in the lower part of the same figure. Shifting the gate or turning the pattern over may cause variations in the casting, due to the different feeding and cooling condi-

tions. It may also give trouble during machining, as the irregularities due to gating come at one point in some of the castings and at another point in others.

To avoid "washing" it is usually desirable to locate the gate in such a way that it will not be in the direct line of flow through the runner. To effect this, the gates may either branch off of the sides of the runner, as in Fig. 27, or if

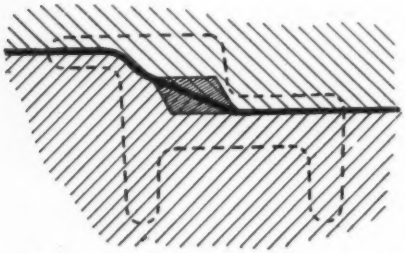


FIG. 30.—GOOD PARTING OBTAINED BY USE OF DIAMOND-SHAPED RUNNER.

this cannot be done, an offset may be provided to check the rush of the metal as in Fig. 28.

Unless the pouring conditions are such as to require feeding the metal up into the mould from the bottom, the runner should be kept as high as possible, so as to get the best metal into the casting proper. This will usually involve putting the runner into the cope. An excellent cross section for the runner is shown in Fig. 29.

The draft on the sides is sufficient to give an easy draw, even though it is in the cope, and the section is heavy enough at all points to prevent danger of chilling. The section, flat on one side and curved on the other, which is sometimes used, should be avoided, as it is too thin at the edges. A rather neat expedient which sometimes proves helpful is the use of a diamond-shaped runner as shown in Fig. 30. If the usual shape of runner had been used, as shown in Fig. 31, the incline at *A* would have been entirely too steep, and there would have been a very objectionable hanging pocket of sand at *B*. The photograph, Fig. 32, shows a runner in which the draft was reversed at different points, the mould board rising above the runner in some places, and at others coming only to the bottom of the runner.

Fig. 32 also shows an enlargement of the runner at the point where the sprue is to be cut. This enlargement should be about 1 in. in diameter on the cope side. It should be kept in the exact centre of the flask whenever possible, so as to avoid flask weights with pouring holes in special locations. Even if the central location is not possible, the sprue should be kept away from the edge of the flask, thus avoiding the danger of the breaking out of the mould.

Risers or shrink balls are required only in special cases to avoid piping or excessive shrinkage in heavy parts of the casting. As a discussion of the points at which they are necessary would lead into an entirely unrelated subject, they are merely mentioned here in passing as details which must be provided for when circumstances require them.

If the pattern is mounted in a vibrator frame, the latter should always rest on top of the mould board as shown in Fig. 33, and never be let down into it. As the surface of the mould board corresponds to the parting surface, the opening in the vibrator frame must be given draft away from the mould board as shown in Fig. 33.

The connection between the pattern and the frame should in almost every case lie on top of the mould board, and should be connected to the frame somewhat as shown in Fig. 34.

In snap flask work, it may be necessary to resort to a band in certain cases. This has been treated in detail elsewhere in this article. If a band is placed in the cope it will clear the connection

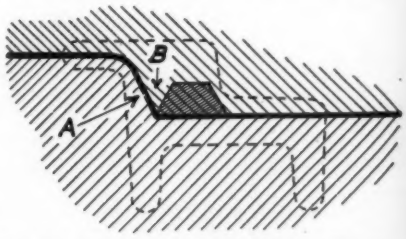


FIG. 31.—UNDESIRABLE PARTING DUE TO SHAPE OF RUNNER.

shown in Fig. 34, but if a band is needed in the drag, this form of connection would necessitate a notch in the band at the very point where the plugging of the hole left by the connection leaves the mould the weakest. To avoid this, the connection may be set into the mould board. This will permit the band to come down to the mould board, that is, extend up to the top of the drag, as shown in Fig. 35.

The Material of the Pattern and of the Runner, Plate, Mould Board, &c,

For patterns which are used sufficiently to prevent them from rusting, cast iron is by far the best material. It is not only cheap, but it meets the requirements of durability and lightness, and its surface, when free from rust and well waxed, gives a clean draw from the sand. If an iron pattern is out of use for any length of time, it is almost impossible to prevent rust spots, and these spoil the surface very quickly. Of course, the length of time in which an iron pattern may remain idle without rusting depends a good deal on the conditions under which it is stored, and the care taken in cleaning and waxing the pattern before it is put away.

If a mould board is used, it is usually desirable to keep the pattern and mould

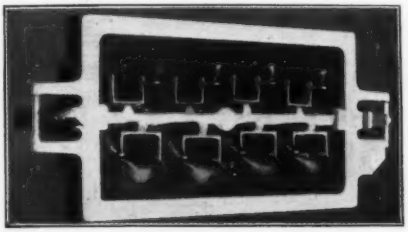


FIG. 32.—USE OF DIAMOND-SHAPED RUNNER WITH DRAFT REVERSED AT DIFFERENT POINTS.

board together. When a wooden mould board is used, a very dry atmosphere shrinks and cracks, while even a moderate amount of humidity increases the liability of the pattern to rust. To avoid changes in the mould board the atmospheric conditions in the pattern storage must be made to correspond, as closely as possible, to those in the foundry. This may compel us, in the case of patterns used only at frequent intervals, to resort to brass, bronze or other alloys, but all of these are heavier than cast iron and the sand has a greater tendency to stick to them. In the case of large patterns they may also be more costly, but in small patterns the possibility of using commercial shapes, which require little or no machining, may permit of savings which will more than offset the extra cost of the material.

Owing to the ease with which they can be soldered or brazed, the above-mentioned alloys may sometimes be desirable for a costly pattern in which extensive changes are likely to be made.

Steel is no better than cast iron in the matter of rusting, and possesses little advantage over brass in weight or cheapness. It is not much used for patterns.

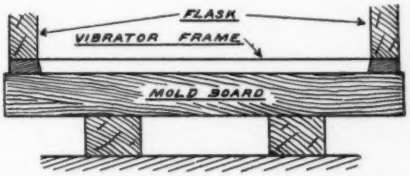


FIG. 33.—DIRECTION OF DRAFT IN VIBRATOR FRAME.

Aluminium is not very well suited for the pattern itself, as it is hardly durable enough, and sand has a tendency to stick to it. It is, however, the best material for plates and for vibrator frames. If made from any other material their weight would be almost prohibitive.

Wooden patterns are entirely unsuited for any but the roughest kind of repetition work. Even if the accuracy required is not very great, it will usually pay better to make metal patterns if a great number of castings is required.

For waxing metal patterns a liquid composed of bayberry wax cut with benzine until it is thin enough to supply with a brush, will be found very satisfactory. By painting with this liquid, a pattern can be waxed more quickly and evenly than by the usual process of heating and rubbing with beeswax. The bayberry wax also gives a superior surface as it dries on in a thin hard coat, free from the stickiness which frequently gives trouble if ordinary beeswax is used. Bayberry wax is used to some

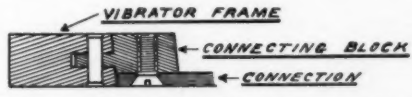


FIG. 34.—SUPPORTING CONNECTION FROM PATTERN TO VIBRATOR FRAME.

extent in pharmacy, and can be obtained from any chemist.

The Points on the Pattern at which Special Accuracy is required,

The importance of accuracy at different points on the pattern is indicated by the order followed in the list below :—

A. Close clearance points at unmachined portions of the casting.

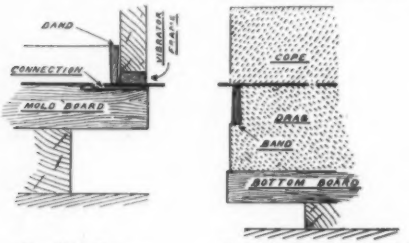
B. Locating points for the various machining operations.

C. Unmachined surfaces which should bear a fixed relation to each other or to machined portions of the casting.

D. All remaining unmachined portions of the casting.

E. Machined portions of the casting.

The machined portions are placed last in the list because a slight variation in



Band testing on mould board. *Band in position in the completed mould.*

FIG. 35.—METHOD OF PROVIDING FOR A BAND IN THE DRAG.

the amount of finish can be tolerated. The accuracy of the pattern at the points where no finish is allowed is far more important, because the final dimensions of the casting depend entirely on the pattern. The locating points are also important, for if the castings from different patterns do not correspond at these points, variable results will be obtained from the machining operations.

Surfaces which are not machined, or which are used as locating points, should always be placed with reference to each other in such a way as to minimise the danger of incorrect spacing due to the possible cumulation of errors in measuring back and forth on the pattern.

Take for example a piece of the shape shown in Fig. 36. The surfaces marked *f* are to be machined, and the legs are to have a width *C* after machining. No special accuracy is needed for the distances *E* and *F*, as any slight variation will be corrected by the machining. On the other hand, if there are slight variations in *G* and *H* the errors might add up, and they might possibly be still further increased by slight errors in *J*, until the final width between the unfinished surfaces might become greater or less than the desired value *D*. But as the outside surfaces are machined to the fixed distance $A + 2B$, the thickness *C* cannot possibly come right unless *D* is right, and a small percentage of error in *D* would cause a considerable error in the width *C*. Many a case in which the wall of metal left after machining is entirely too weak, or in which the cutters fail to clean up a boss, or in which they dig in after milling the boss away entirely, is due to disregard of these facts.

In entering each dimension care should be taken to make the number of decimal places correspond to the degree of accuracy required, in accordance with the method described in the first part of this paper.

The Amount of Work to be Expended on the Pattern.

The first item to be considered is the outlay on drawings, and there are really only two courses open to us. We can choose between making the drawings and not making them. We can avoid all unnecessary "frills" on them, but if they are made at all, they should be complete and reliable. They should be omitted only in very unimportant patterns, or in the case of patterns which fall into the very lowest grades of the repetition class.

In the actual construction of the patterns there is more opportunity for grading the work to suit the requirements, and for devising means of producing the pattern quickly and cheaply. In planning the method of executing the work, we should consider, first the degree of accuracy required, and second the expenditure which will give the most

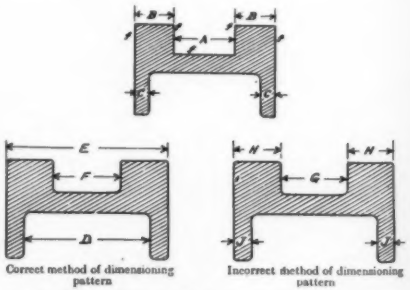


FIG. 36.—ARRANGEMENT OF PATTERN DIMENSIONS.

economical relation between investment and earning capacity. Careful attention to the varying degrees of accuracy, indicated on the drawings in the manner already referred to, will enable all un-

necessary refinements to be avoided, and with a little ingenuity, labour-saving short cuts can almost always be devised.

The form of the pattern should be studied to determine whether to build it up, cut it out of the solid, make it from a casting which is machined all over, or from a casting machined only at certain points.

In the case of built-up patterns it is often possible to use commercial brass rods which require no finish, or to use bars of any desired cross section which can be milled to shape accurately and cheaply by means of fly cutters, and then cut up as needed.

Many small patterns can be made from a solid bar of brass or cast iron more cheaply than from individual castings. If a pattern is of such a shape that it can best be produced from a casting, it may pay to make an accurately finished metal master pattern, castings from which can be finished up with the minimum amount of machining. Frequently the machining can be omitted altogether, the only finish required being a smoothing up with files and emery cloth. Or certain spots may be machined and the balance smoothed up. Of course, in making castings for this purpose care must be taken to avoid excessive rapping and to use a fine sand which will give the smoothest possible surface. To avoid errors due to hand-moulding it may also pay to mount the metal master pattern for temporary use on a moulding machine.

The relation between working patterns, master patterns, and grand master patterns can perhaps be brought out most clearly by quoting the following rules which the author drew up some years ago, and which have been followed since that time with good results :—

Rules.

All patterns will be classed under one of the three following heads :—*a*. Working patterns. *b*. Master patterns. *c*. Grand master patterns.

Working patterns used for *repetition work* shall be of metal, and in most cases mounted for use on the moulding machines.

Working patterns used for *experimental work*, or for *jobbing work* shall be, in most cases, of wood. When practicable, they shall be arranged for temporary mounting for use on the moulding machines.

Master patterns may be of wood or metal, according to circumstances. When the piece to be produced permits, the working patterns shall be made by smoothing up castings taken from a metal master pattern. In cases in which it is preferable to machine the working patterns, the master pattern usually shall be of wood.

Grand master patterns shall be of wood, or if made of metal shall be built up out of stock material. They shall be used in cases where it is necessary to obtain a casting out of which to make a metal master pattern.

Excepting in special cases, for which special provisions are made, the following general instructions shall be observed in making patterns and in making drawings for them.

Metal Working Patterns.

Metal working patterns are the standard patterns for repetition work.

They are *made from drawings* showing the finished dimensions of the pattern itself. These drawings will be dimensioned to cover all necessary allowances for finish, shrinkage, and draft, and there will be no further allowance in making the pattern.

They are *made by* smoothing up castings obtained from the metal master pattern or by machining castings obtained from the wooden master pattern, or by building up out of stock material.

They are *mounted* for use on the moulding machines in accordance with the carding drawing.

They are *stamped* on the runner with the part number of the first piece produced from this casting. If one casting is machined to make several different pieces, the pattern will still have only one pattern number, which will be identical with the part number of the first piece produced. Each card will have a distinguishing mark, usually one dot on the first card, two on the second, etc., which will be placed so as to be visible in the casting even after it is machined. This mark will be in each pattern of the card, and alike in all patterns of any one card. Even if there is only one card, the distinguishing mark is to be put on it, as another card might be made later.

Wooden Working Patterns.

Wooden working patterns are the standard patterns for experimental or jobbing work.

They are *made from drawings* showing the finished dimensions of the piece.

The pattern must, therefore, be made with allowance for single shrinkage, draft and finish, as noted on the drawing.

They are *mounted* for use on the moulding machines whenever practicable.

They are *stamped* with the pattern number, which corresponds to the number of the finished piece. If one casting is machined to make several different pieces, the pattern will still have only one pattern number corresponding to the number of the first piece produced from it.

Particular attention is directed to the fact that patterns for runners fall under this heading and must comply with these requirements.

Metal Master Patterns.

Metal master patterns are used to obtain castings suitable for use as working patterns after they have been smoothed up, or used in cases in which a wooden master pattern would not be durable enough.

They are *made from drawings* showing the finished dimensions of the metal master pattern itself. These drawings will be dimensioned to cover all necessary allowances for finish, shrinkage and draft, and there is to be no further allowances made when making the pattern.

They are *made of* castings obtained from the grand master pattern, or by building up out of stock material.

They are *mounted* temporarily for use on the moulding machines to facilitate the obtaining of good castings.

They are *stamped* with the pattern number.

Wooden Master Patterns.

Wooden master patterns are used in cases in which the metal working pattern has to be machined.

They are *made from drawings* showing the finished dimensions of the metal working pattern. Allowance for single shrinkage, and an additional allowance for finish all over must be provided when making the pattern.

They are *mounted* temporarily for use on the moulding machines when practicable.

They are *stamped* with the pattern number.

Grand Master Patterns.

Grand master patterns are needed only in cases in which a metal master pattern has to be made out of a casting.

They are *made from drawings* showing the finished dimensions of the *metal master pattern*. Allowance for single shrinkage, and an additional allowance for finish, as marked on the drawing, must be provided when making the pattern.

They are *mounted* temporarily for use on the moulding machines when practicable.

They are *stamped* with the pattern number.

The distinguishing mark on each pattern which is referred to in the rules above quoted is provided for the purpose of identifying the card from which a given casting was produced. This is a necessary feature if duplicate sets of patterns are run.

In discussing the flask sizes, reference has already been made to the use of a few patterns in a small flask for such patterns as would not warrant a larger pattern equipment. And even if a smaller flask is not practicable or desirable, it may often pay to make and card only a few patterns, leaving the balance of the mould unused, in preference to spending money in the tool room which the saving in the foundry might not offset in years.

When undertaking new work it is always a wise precaution to make and card only a part of the patterns, leaving the balance to be added later so as to facilitate the making of any changes or improvements which may suggest themselves in turning out the first few lots.

In the same way, if it is desirable to put through a limited number of castings from a new pattern to test out the tool equipment, much valuable time can often be saved by getting the castings as soon as a single pattern can be made and carded. The remaining patterns of the card can be added later.

If a portion of the mould is unused, do not spread out the patterns. Card the ones which are nearest to the sprue, and keep them close together to avoid waste of metal in the runner.

It is usually false economy to mount two or more different patterns on one card. Even if it seems that the proportion in which they will be used can be definitely fixed, for instance, in the case of rights and lefts, unforeseen circumstances may arise at any time to upset the calculation. Repair orders may be heavier for one casting than for the other, or a batch of work from one casting may be spoiled and have to be scrapped, or the loss in the foundry or in the factory may be heavier for one

than for the other. These and similar conditions may make it necessary to increase the output on one of the castings, and this is always troublesome and wasteful if different patterns are mounted on a single card.

One detail which it is necessary to watch is the tendency to "save time" by being careless in regard to the radii of fillets and rounds. A fillet is often difficult to produce, but that is no reason for shirking the work on it. Pattern-makers should be provided with radius and fillet gauges, and should be made to work to them.

The guide pins on each "plate," frame, etc., should be carefully fitted to a gauge so as to ensure squareness and accurate spacing. A single adjustable gauge with a series of dowelled settings may be used to cover the entire range of flask sizes.

If careless work is permitted in the fitting of these pins, the foundry is driven to a more or less ineffectual tinkering of the flask pins every time a pattern is changed. If proper precautions are taken to maintain the standard, all patterns and flasks of the same size will be perfectly interchangeable. A little graphite (not oil) should be used to lubricate the pins, and the fit should be as tight as is consistent with a smooth lift.

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THE SZEKELY PROCESS.

In the FOUNDRY TRADE JOURNAL for November an article was printed on sandless castings, by Mr. J. H. Shaw. This process depended upon the casting of iron in metallic moulds. Messrs. R. Waygood & Company, Limited, of Coventry, have been experimenting with a somewhat similar process in which the interior of the mould is coated with a composition which will adhere to a hot iron surface. It is on this composition that the patent depends, and although no information has been offered as yet as to its nature, it is understood to consist partly of French chalk and paraffin. One of the features of the process is the absence of shrinkage.

The process is the invention of Dr. Charles Szekely, of 113, Clement's Inn, W.C., and in addition to having been used for some time past at the works of Messrs. Alfred Herbert & Company, it has been demonstrated before a Commission of the United States Patent Office. We hope to describe the process fully as soon as the patents are issued. In the meantime, it may be stated that the castings are exceedingly sharp, and have a good surface.

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GLASS AS A FLUX IN BRASS MELTING.*

BRASS melters shun fluxes, for the reason that they attack the crucible. It is one of the instances where a material is good in theory and not in practice.

There is no question about the value of a flux in melting metals. It serves to protect it from the action of the air and gases of the fire. When a flux is used, the loss of spelter in brass melting is less. It answers the twofold purpose, then, of protecting the brass and reducing the spelter loss. By the use of a suitable flux (glass), brass rolling mill manufacturers have been able constantly to keep their spelter loss considerably below 1 per cent.

Glass is an excellent flux in brass melting, for the reason that it does not become actually liquid at the temperature of melted brass, and therefore does not attack the crucible. It becomes pasty, and so covers the metal, and it is readily skimmed off, a difficult operation with a liquid flux.

Assuming that a No. 60 crucible is used, a couple of pounds of broken glass are placed in the bottom before the metal is put in. When the melting begins, a handful of common salt is thrown in, as usual, and the melting allowed to continue. When the metal is ready to pour, the glass will be found on the top of the metal in the form of a soft "pancake," which may be readily skimmed off. The crucible is not attacked.

The cheapness of glass and the fact that the crucible is not attacked, renders its use attractive, and many manufacturers have been accustomed to employ it for a long time. Its good effect, however, is not generally known.

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MR. H. T. WRIGHT, has been appointed liquidator by Howard T. Wright Brothers, Limited, engineers, for the voluntary liquidation of the company's assets, with a view to investing the whole of the company's capital in a subsidiary company. There is no question of a deficit.

* "Brass World."

A BURNING QUESTION.

By J. Clements.

Many of the burning questions of to-day are political, but the section of the community to which I belong (that of moulders), have one peculiarly their own, *i.e.*, the one I shall deal with.

In Fig. 1 will be seen the castings being burned in, and in Fig. 2 some of the more intricate castings shown with lugs or projections on, these simply being cast on them for bolting on machine in finishing.

In the first place, to burn up a casting is not like having a patch put on an old kettle by the soldering process, though it may be done to remedy a defect; in my experience I have known people that would not have a casting burnt up, but in most circumstances this can only be ascribed to arrogance or blissful ignorance.

Coming a step nearer, I will take a few cases in point. A large casting of an intricate nature that has taken up considerable time of probably one of the most skilful workmen is turned out, and by some oversight in the making or maybe after it has been made, a lug or some projecting piece has got knocked off, and the casting is useless and proves a great loss, but here comes in the burning question.

If the casting is hollow or full of cavities, the best plan under the circumstances is to fill these cavities and hollow places with sand, and then before commencing the burning in, to see it properly dried. These precautions are absolutely necessary for two reasons, viz.: Firstly, the process of burning in means that the casting is liquified at a given part, and if not filled in with sand the metal would find its way into the casting and fill all the hollow places and spoil the work at once. Secondly, the sand must be thoroughly dried that has been rammed up, so that during the burning in process no steam shall be given off, otherwise it will be useless owing to blowholes.

If the casting be one of either gunmetal, or more especially phosphor bronze, other precautions will be necessary beyond those mentioned, for after the casting is burnt up or the piece burnt on, it will be found very advisable to take it from the sand, and when the surplus metal has been ground off by the emery wheel, to place the casting in the core oven, thus taking the whole of the casting to an even temperature, and afterwards placing same in a warm place, so as to cool down

Fig. 1.—Burning up Castings.

evenly; this course will often be found useful, and save many castings that would otherwise crack, through the sudden and unequal expansion and subsequent contraction that must inevitably take place.

One source of trouble to myself in this direction occurs in this way; many engines and boilers that were manufactured years ago, in the natural course of events, with wear and tear, want parts renewing, and in the meantime, patterns have been altered to suit the present times, and various improvements added, but the fitting must be a facsimile of the one that it is wanted to replace. Usually the new kinds of fittings are found wanting, perhaps a lug wants putting on, or if a spindle, this may want to be an inch or two longer. Then comes our chance, for no new patterns will be made, but these little incidentals are burnt on at a few minutes' notice, thus saving valuable time in many ways.

Water gauges and check or boiler valves are often sent down, the first named being drilled generally in the flange to receive four bolts. These are often wanted for repair work, with three or six holes instead; then the existing holes are burnt up and neatly finished, and the holes drilled to suit.

Similarly, the check or boiler valves are often treated, it sometimes being necessary to take special means of avoiding certain rivets by having eight holes in flange instead of four, this especially, in the case of heavy valves. One of the hardest metals (not alloys) to burn up or patch in my experience is aluminium, and certainly at the present time it is getting quite a common thing in respect to motor-car work to want castings burnt up.

After a smash up there is, generally, a dilapidated crank case, and the first thought to the owner probably is that a new case must be had, but provided it is not in too bad a state, it may be remedied by putting a burn or two on, and thus patching up the holes; this in itself means a great convenience, and also a great saving too, as a new case would want finishing and machining; but to the founder that is used to burning an occasional gun-metal casting, aluminium will at first be found a trying experience. In the first place, where the casting requires to be burned, it must be filed clean, otherwise it will be time thrown away; and in the second place, hot metal will be more necessary than is the case in gun-metal, and plenty of it too, as it takes a considerable amount before it seems to have any appreciable effect in liquifying the surrounding metal.

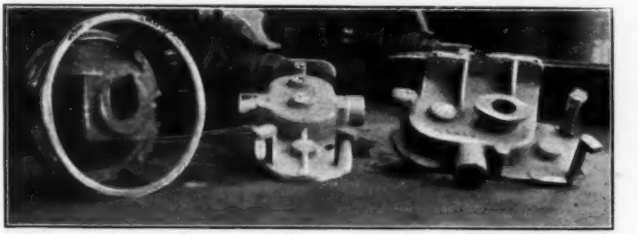

FIG. 2.—CASTINGS WITH LUGS AND PROJECTIONS.

Many pneumatic appliances, such as riveters and portable drillers, for the sake of lightness, have aluminium for casing in the mechanism, these too, like the above, at times come to grief; and when it is found that a job can be made of them in a short time, if they are not completely wrecked, it means a great time saved to a busy shop, and a great factor in economy.

Take another instance that occurred in a foundry in which I was engaged some years ago. At the time of which I speak the firm had an order for a special memorial plate for a large public building. Surmounting the top of plate were two ornamental pieces in bronze. These two pieces constituted a right and left hand, and in fitting up should have been cut and fitted to alternate sides of the plate, but unfortunately were cut alike and finished, and but for being able to restore the half that had been cut wrong, a new one

would have been required to have been cast and finished, but this was obviated by burning on a piece as follows :—

The original pattern was moulded in the same way as if making a fresh one, then the pattern taken from the sand and the spoilt casting very carefully inserted in its place; the piece was then cast on in the mould, and running the metal away in another direction till sufficiently burnt up. In this way the cost of finishing the complete piece was saved, excepting for the small piece added in this way, and that of itself was a small item.

Only actual practice can tell of the many times that heavy costs have been saved to the owners of foundries, seeing that a man's time is but a small proportion of the heavy loss sometimes incurred by wasters.

Most of the readers of this journal will remember the trouble that arose through the fact leaking out that the casting of a rudder supplied to one of our ironclads was faulty. Be that as it may, I only mention this in conjunction with this article to say emphatically that if any flaw existed in any such casting, owing to its size and further use, no attempt at patching it up should in any shape or form have been considered advisable. When burning anything large is necessary, a corresponding amount of metal would have to be used, and the responsibility of such an operation is so great that no possible risk should be taken. The case in point may have, however, far-reaching effects, and possibly open up the way for the inspection of such castings by men who would know the likely places to look for such defects.

"Thermit" that we are now hearing about is a patent way of burning and joining two surfaces together, but if any readers wish to know particulars of this, no doubt they can easily get any information.

In concluding this article I hardly think I shall be out of order in saying a few words relative to "filling-in" in contra-distinction to "burning in." Nowadays, we can see advertised largely cement under various names for filling in castings that are faulty, owing to blowholes, sand holes, etc. Except for occasional use, I think this method shoddy, as it is, should be deprecated. The moulders should have pride enough to make good sound castings, and the foreman should be in a position to explain matters thoroughly with that end in view, if necessary. Certainly, there are exceptions, such for instance, say as a large gas engine bed, other bed-plates or parts of machinery that have no wear and tear; but this practice should only be resorted to in extreme cases under the above circumstances.

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THE TREATMENT OF SKIMMINGS.*

SKIMMINGS are the principal material which a brass founder sells to the scrap-metal dealer. It is this which he accumulates until he has a sufficient quantity to pay for handling it. Ashes are usually looked upon as nearly worthless on account of the fact that little metal can be seen in them, but skimmings are considered as one of the valuable assets. Metal is quite prevalent in it, and therefore the value becomes apparent to the naked eye.

Many brass founders throw their ashes and skimmings together and sell them in this condition. Others carefully riddle out the coarse, wash it, and then sell the fine. The majority of founders, however, sell their skimmings as they are after the large pieces of metal have been removed.

Unless the skimmings are carefully looked after, they will be a source of much loss to the brass founder. Many large pieces of metal, such as gates, imperfect castings, risers or spatters find their way into the barrel of skimmings. They are soon covered up, and when the whole is sold they cannot be seen. When skimmings are purchased and the market price is paid for them, it is a good thing for the scrap-metal man if he can obtain good, heavy metal at the same price. Skimmings are the source of a large loss to brass-founders every year, from not realising that they can be treated so they will show a minimum loss to the foundry and yet have the scrap-metal man better satisfied than before (that is, if he does business along business lines).

The first operation in their treatment is to riddle them through a fine riddle. This separates the fine from the coarse. Do not imagine that because the fine material contains only a few particles of metal that it is not valuable. It may run from 20 to 30 per cent. in

* "Brass World."

copper, and even more. There is no difficulty in selling it. Do not wash skimmings, or this fine material will be washed away. They should be riddled as the first operation, and the fine material retained until the opportunity for sale occurs.

The coarse material that is contained in the riddle contains slag, pieces of coke, metal, old crucibles, spatters, and skimmings. Hand-picking is the only treatment that can safely be given this, and a good, careful man should be entrusted with it. The first operation is to pick out the gates, risers, castings and spatters that are really good metal and can be easily remelted. Old crucibles should be thrown on one side and the metal chipped from them when the opportunity comes to hand.

The remainder of the material, consisting of coke, slag, and skimmings, is either sold directly or washed. If washed, the metal which they contain is recovered. This is, of course, the best method of handling them, and shows the most profit to the brass founder. If sold, a better price can be obtained from them than would be the case were the fine left in.

It is the practice in many brass foundries to wash the skimmings in a Hill barrel, in the same manner that ashes are treated. This is bad practice, as it results in completely washing away the fine material.

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LIST OF NEW INVENTIONS.

Specially compiled for THE FOUNDRY TRADE JOURNAL by MR. GEORGE BARKER, Fellow of the Chartered Institute of Patent Agents, Consulting Engineer and Chartered Patent Agent, 77, Colmore Row, BIRMINGHAM.

22,895. J. NEWTON and C. BILLINGTON, Stoke-on-Trent. Improvements in chills, and mode of use in making chilled metallic castings.

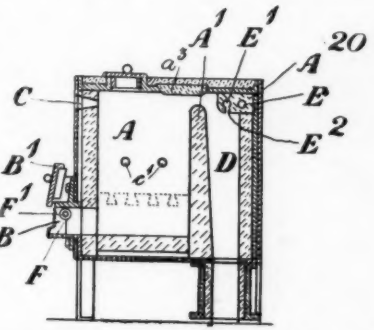
23,094. W. O'KEEFE and S. STRETTLES, Manchester. Improvements in machines for use in drawing patterns in moulding.

23,400. G. TEIKE. Improvements in and relating to toothed wheels moulding machines.

8,615. C. MOREHEAD, Rugby. Improvements in or relating to stoves for drying moulds and the like.

This invention relates to stoves for drying moulds and the like, and particularly to that form of stove through which air from an induction opening flows under the action of a propelling jet of air, which has been heated prior to its issue through the jet openings.

The figure shows a vertical section through the stove in which A is the fire space in communication with the air inlet B controlled by a damper B^1 which is adjustable, C and C^1 are additional air ports in the front and sides of the chamber. At the back of this chamber, separated by a bridge A^1, is a vertical flue D



communicating with A at the top, and with its other end with an outlet adapted to fit over the mouth of the mould to be dried.

A cock controls the supply of compressed air to the pipe F, and another cock F^2 controls the air to another supply pipe leading to the conduit E. According to this invention the air passes along the holes E and E^1 in the refractory material A^{20}, and is thus heated by the fire; the hot air issues from the holes E^2 in the passage E^1 and is thus directed down the flue D to the mould to be dried. The portion A^3 which is of ganister or fire-brick is made renewable so as to resist the wear of the flames.

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MESSRS. T. & H. WALKER, of the Samson Iron Works, Bradford, have established branch offices at 2, Charles Street, Bradford.

MESSRS. A. PANK & SON, Duke's Palace Iron Works, Norwich, have acquired the engineering business of Messrs. Holmes & Sons, Bedford Street Works, Norwich.

MR. G. A. BECKS, 4 and 5, Queen Anne's Chambers, Westminster, London, S.W., has been appointed the London agent of the Irwell Steel Foundry Company, of Manchester.

TRADE TALK.

THE PARK LANE FOUNDRY, Tipton, is being offered for sale by private treaty.

MR. W. URE, of the Crownpoint Foundry, Glasgow, is retiring from business.

MESSRS. C. E. ROBERTS and P. APPLEBY, engineers, etc., Manchester, have dissolved partnership.

MESSRS. MILLAR, DENNIS & COMPANY are removing their brassfoundry business to the Victoria Works, Thornton Road, Bradford.

MR. G. THURLOW, of Messrs. G. Thurlow & Company, engineers, Stowmarket, has purchased the Suffolk Iron Works, Stowmarket.

A DISSOLUTION of partnership is notified in connection with Messrs. M. Hurd and H. H. Brimson, mechanical engineers, Reading.

THE LAWRENCE PATENT WATER SOFTENER AND STERILISER COMPANY, LIMITED, have removed to 34, Victoria Street, Westminster, London, S.W.

MESSRS. R. W. MUIR and L. FORSYTH, engineers, St. James's Road, Glasgow, have dissolved partnership. Mr. Forsyth has taken over the business.

THE LANCASHIRE MACHINE-TOOL AND FITTINGS COMPANY, Warrington, have acquired the business of Mr. B. Garside, Golborne Street, Warrington.

THE SHELTON IRON, STEEL & COAL COMPANY, LIMITED, have opened new branch offices at 63 and 64, Exchange Buildings, Birmingham.

A. HARPER & SONS, LIMITED, Waddam's Pool Iron Works, Waddam's Pool, Dudley, Worcester, will in future trade as A. Harper, Sons & Bean, Limited.

THE STIRLING BOILER COMPANY, LIMITED, of Motherwell, have removed their head office from Motherwell to 25, Victoria Street, Westminster, London, S.W.

A FIRE broke out recently on the premises occupied by Messrs. M'Callum & Hope, ironfounders, Maryhill, Glasgow, doing damage estimated at £1,000.

THE DEVONSHIRE ENGINEERING WORKS, Keighley, Yorkshire, of Messrs. John Dickinson & Company, are being offered for sale by private treaty as a going concern.

MESSRS. T. L. FELLOWES and R. FELLOWES, ironfounders, Kingston-upon-Hull, who traded as the Kingston Foundry Company, have dissolved partnership.

MESSRS. B. BROWN, S. ROBINSON, W. J. COOK, J. J. COOK, S. STRICKLAND, and J. H. RAWSON, engineers, etc., St. Helens, Lancashire, have dissolved partnership.

HADFIELD'S STEEL FOUNDRY COMPANY, LIMITED, of Sheffield, have a contract to supply 520 manganese steel bushes and 160 manganese steel pins to the Thames Conservancy.

MESSRS. ANDREW BROWN & COMPANY, of 110, Cannon Street, London, E.C., have been appointed agents for Urquhart, Lindsay & Company, Limited, Blackness Foundry, Dundee.

THE old-established ironfounding firm of Messrs. Jas. Allan, sen., & Son, Elmbank Foundry, Glasgow, have been obliged to suspend payment owing to losses in business.

AN inquiry with regard to the draft regulations for the casting of brass, will be opened at the Council Chamber, Municipal Buildings, Birmingham, on Monday, December 16.

JAMES & RONALD RITCHIE, LIMITED, of the Acklam Foundry, Middlesbrough, have been successful in having their name placed on the Admiralty list for cast-iron pipes and fittings.

HEENAN & FROUDE, LIMITED, Newton Heath Iron Works, Manchester, have opened offices at 56, Victoria Street, London, S.W., under the control of Mr. Robert H. Hammersley Heenan.

MESSRS. BAXTER & CAUNTER, 86, Charing Cross Road, London, W.C., have been appointed sole London and Southern and Eastern Counties agents for the Credenda Conduits Company, of Birmingham.

MR. R. DUNLOP, formerly Liverpool district representative of the Carron Company, has established himself in business at 14, Dale Street, Liverpool, and will represent the Sinclair Iron Company, Limited.

NEW engineering works are being erected at Sunnyside, near Wishaw, Lanarkshire, for Mr. Alex. Jack, who was lately connected with Messrs. Marshall, Fleming & Jack, crane makers, etc., of Motherwell.

THE business of Messrs. R. Warner & Company, engineers, London, and Walton-on-the-Naze, has been turned into a limited liability concern under the style of Robert Warner & Company (Engineers), Limited.

Contractors to H.M. Government.

FOUNDRY LADLES

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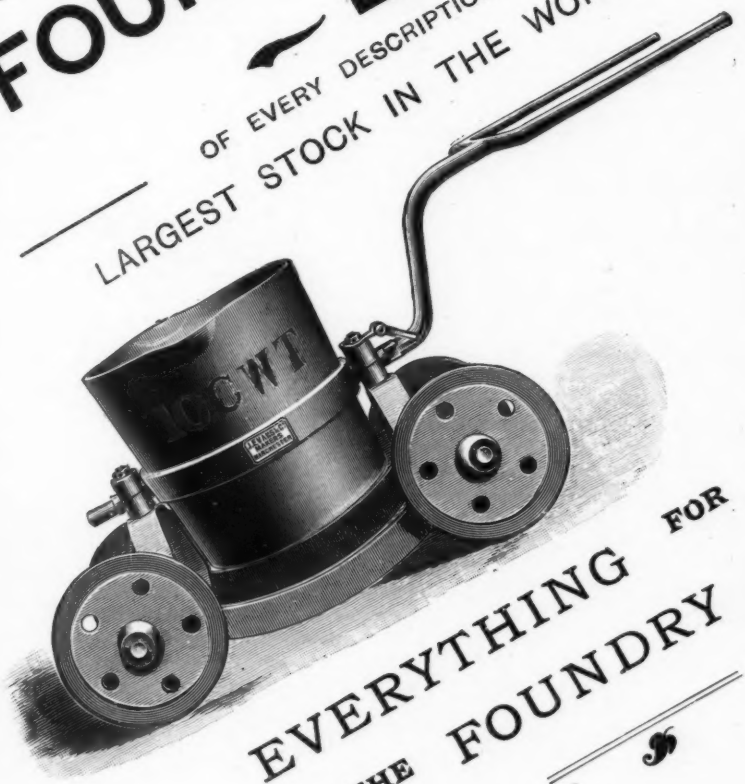

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NEW COMPANIES.

CLIFTS ENGINEERING, LIMITED.—Capital £10,000 in £1 shares.

INTEROCEANIC ENGINEERING COMPANY, LIMITED.—Capital £15,000 in £1 shares.

ALEXANDRA IRON WORKS COMPANY, LIMITED.—Capital £2,000. Registered office: 149, Fleet Street, E.C.

B. THORNTON & SONS, LIMITED.—Capital £1,000, to carry on the business of engineers, etc., at Brighouse.

THOMAS & CLEMENT, LIMITED.—Capital £10,000, to acquire the engineering business carried on at Llanelly, as Thomas & Clement.

JOHN LEES & SONS, LIMITED.—Capital £4,000, to take over the engineering business of L. W. Lees and S. Lees, Grove Foundry, Gomersal.

NORTHERN ENGINEERING AND CONSTRUCTION COMPANY, LIMITED.—Capital £3,000. Registered office: 17, Collingwood Street, Newcastle-on-Tyne.

SHEFFIELD TOOL AND GAS ENGINE COMPANY, LIMITED.—Capital £5,000, to acquire the existing business. Registered office: Porter Lane, Sheffield.

MUIR & FORSYTH, LIMITED.—Capital £5,000, to acquire the existing business of engineers, etc. Registered office: 97, St. James Road, Glasgow.

S. CULPAN & SON, LIMITED.—Capital £5,000, to acquire the business carried on at the Holme Bank Foundry, Rawtenstall, as S. Cuplan & Sons.

W. H. POTTER & SONS, LIMITED.—Capital £20,000, to take over the business of shipbuilders and engineers, carried on at Liverpool as W. H. Potter & Sons.

WHALE, HIGHWAY & WILKES, LIMITED.—Capital £5,000, to acquire the ironfounding business at the Stella Works, West Bromwich, of Whale, Highway & Wilkes.

MARCHANT BROTHERS, LIMITED.—Capital £1,000, to carry on the business of ironfounders, etc. Registered office: Verney Wharf, Verney Road, Rotherhithe, S.E.

CROW, HARVEY & COMPANY, LIMITED.—Capital £25,000, to acquire the engineering business of Crow, Harvey & Company. Registered office: 89, Sussex Street, Glasgow.

JAMES ALLAN, SEN., & SON, LIMITED.—Capital £30,000, to acquire the business of ornamental ironfounders carried on by James Allan, senior, & Son, Elmbank Foundry, Glasgow.

SAMUEL WHEELER, LIMITED.—Capital £7,000, to acquire the engineering business of S. R. Wheeler. Registered office: Soho Boiler Works, London Street, Smethwick.

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DEATHS.

MR. J. SUTTER, secretary to Caldwell & Company Limited, engineers, Glasgow.

MR. C. SUTCLIFFE, of Messrs. Sutcliffe & Gee, engineers, Ripponden, near Halifax, aged 41 years.

MR. J. ALLEN, son of Mr. W. Allen, Union Brass and Iron Works, Manchester, aged 28 years.

MR. E. ROBERTS, head of E. & H. Roberts, Limited, Deanshanger Iron Works, Stony Stratford.

MR. J. BEDNAL, a director of Wm. Cooke & Company, Limited, Tinsley, Sheffield, aged 79 years.

MR. J. BALDWIN, of Messrs. J Baldwin & Company, Devonshire Brass Works, Keighley, Bradford, aged 68.

MR. J. APPLEBY, late of the firm of Messrs. Appleby & Brogden, ironfounders, Scarborough, aged 73 years.

MR. S. J. SUMMERSON, chairman of the firm of Thomas Summerson & Sons, Limited, Albert Hill Foundry, Darlington.

SIR WM. G. PEARCE, Bart., chairman of the Fairfield Shipbuilding and Engineering Company, Limited, aged 46 years.

MR. T. A. BRIERLEY, at one time connected with the Leeman Road Engineering Works, Halifax, at the age of 72 years.

LIEUTENANT-COLONEL JOHN DALGLISH, head of the firm of John Dalglish & Sons, Avenue Iron Works, Pollokshaws, Glasgow, aged 50 years.

LORD NUNBURNHOLME, at his residence, Warter Priory, Pocklington, Yorks. The deceased was chairman of Earle's Shipbuilding and Engineering Company, Limited.

MR. HENRY LANE, who was for 33 years connected with our contemporary, "The Colliery Guardian." The deceased was very widely known throughout the engineering trades in this country.

MR. R. LAIDLAW, head of R. Laidlaw & Son, Limited, Alliance Foundry, Glasgow, and the Barrowfield Iron Works, Limited, at his residence on the Isle of Bute, aged 71 years. The firm of Laidlaw & Son was founded by his father.

PATENT

ALUMINO THERMIC

REG. TRADE MARK.

WELDING PROCESS

— FOR —

BROKEN CASTINGS.

REPAIR SHOP

NOW OPEN.

ESTIMATES for WORK and ILLUSTRATED PAMPHLET upon application to

THERMIT LIMITED,

27, MARTIN'S LANE, CANNON STREET, E.C.

ELDERS FOUNDRY COKE

As supplied to the British . . Admiralty Dockyards.

The following, selected from numerous letters, are eminent testimony as to the quality of our celebrated "A.A.A." Coppee Foundry Coke, carefully selected, and despatched in sheeted wagons.

From PECKETT & SONS, Bristol.

Bristol, October 25th, 1904.

We have been using your Selected Foundry Coke for some considerable time.

We have pleasure in stating that we are very pleased with it, as we find we get sounder and cleaner castings, more free from blow-holes and other defects, than we formerly did.

From MOUNTFORT PHILLIPS & Co., Llantrissant.

Llantrissant, October 25th, 1904.

In reference to the Foundry Coke you have been supplying us with for the last six months, we have very great pleasure in letting you know that it has given every satisfaction, and that our Works Manager and Workmen give it the highest praise.

Elders Navigation Collieries, LTD. Cardiff.

PERSONAL.

MR. J. CROMPTON, engineer and toolmaker, of Coventry, has been appointed a local J.P.

THE late Mr. W. G. Bagnall, of the Castle Engine Works, Stafford, left estate valued at £7,818.

SIR WM. H. STEPHENSON has been re-elected chairman of the Tyne Improvement Commission.

MR. ALFRED HARRISON has been elected a director of Richardsons, Westgarth & Company, Limited.

MR. J. M. ALLAN and MR. J. T. BATEY have been elected directors of Hawthorn, Leslie & Company, Limited.

THE late Mr. R. A. Sorby, formerly of Messrs. Sorby & Sons, edge tool manufacturers, Sheffield, left estate valued at £7,113.

MR. M. L. HALL, of Joshua Heap & Company, Limited, engineers, Ashton-under-Lyne, has been elected an Alderman of the Borough.

THE personal value of the estate of the late Mr. G. Somerville, of Messrs. Somerville & Crombie, Gilmore Park Engine Works, Edinburgh, is £8,331.

THE gross value of the estate of the late Mr. J. Watson, chairman of Matterson, Huxley, & Watson, Limited, iron-founders, Coventry, is £41,825.

MR. J. W. SUMMERS, of John Summers & Sons, Limited, Globe Iron Works, Stalybridge, has been chosen as the next Liberal candidate for Flint Boroughs.

MR. E. M. SAWTELLE, London district manager of the British Westinghouse Electric and Manufacturing Company, Limited, has been appointed territorial sales manager, with headquarters at the works at Manchester.

MR. J. HILL, of the St. George's Engineering Works, Derby, has been the recipient of a presentation from his employés on the occasion of his election to the local Town Council.

MR. T. CANTRELL, who recently retired from the secretaryship of Manlove, Alliott & Company, Limited, engineers, Nottingham, has been the recipient of a presentation in recognition of his 46 years' service.

DR. FRANCIS ELGAR has been elected chairman of Cammell, Laird & Company, Limited, and has also rejoined the board of the Fairfield Shipbuilding and Engineering Company, having been elected chairman *pro tem.*

MR. E. OAKES, of 46, Ashfield Road, Rusholme, Manchester, has been elected hon. sec. *pro. tem.* of the Lancashire Branch of the British Foundrymen's Association, in place of Mr. Bransby, who has gone abroad.

MR. M. S. GIBB has been appointed manager of the Central Marine Engine Works, West Hartlepool, in place of Mr. Borrowman, who has resigned on account of ill-health. Mr. J. B. Williams becomes assistant manager of the works.

Mr. A. H. HOY, general manager of Beyer, Peacock & Company, Limited; Mr. G. Tangye, chairman of Tangye's, Limited; and Mr. H. Marshall, a director of Marshall, Sons & Company, Limited, have been appointed on the committee of the British Weights and Measures Association.

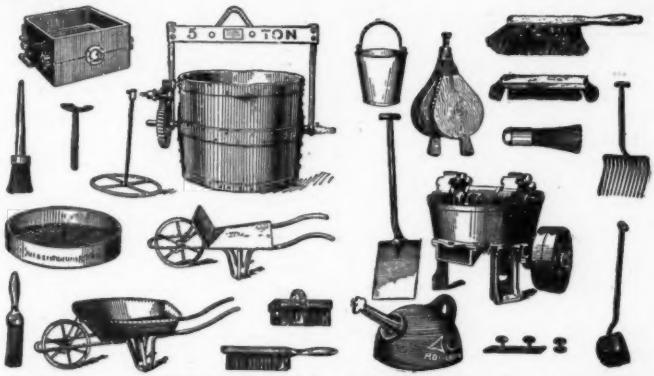
MR. N. E. ROBSON, works manager of the Northumberland works of the North-Eastern Marine Engineering Company at Wallsend, has been appointed works manager at Messrs. William Denny & Company's Engine Works, Dumbarton. Mr. Robson will be succeeded by Mr. Hermann Luhrs.

Ganister, Cupola Blocks, Fire Bricks,
Fire Clay.
Silica Bricks, Tuyeres, Stoppers, Nozzles, &c.
Steel Moulders' Composition, Silica Cement.

J. GRAYSON LOWOOD & Co., Ltd.,
DEEPCAR, nr. SHEFFIELD.
Telegrams: "LOWOOD, DEEPCAR."

Established 1863.

Jas. Durrans & Sons,



PHŒNIX WORKS, PENISTONE, Near Sheffield.

Manufacturers of all

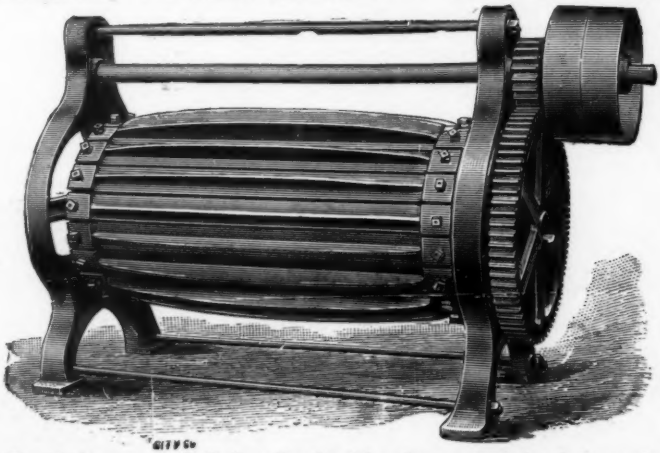
FOUNDRY EQUIPMENTS,

Composition Black Lead,

Plumbago, Core Gum, White Dust, and Coal Dust.

Ladles, Cupolas, Fire Bricks, Gannister, Stone Flux, Loam and Sand Mills, Casting Cleaners, Studs, Chaplets, Pipe Nails, Sprigs, Brushes, Wire Brushes, Core Ropes, Bellows, Buckets, Spades, Forks, Riddles, Sieves, Barrows, &c.

IMPROVED FOUNDRY RATTLER or FETTLING DRUM.



These Machines are invaluable for a Foundry, doing a larger amount of work of a superior quality, in a much shorter time than can be done by hand, with out skilled labour.

"Dear Sirs,—We have been using your best Blacking for a large number of years, and always use it on our large Ingot Moulds, which, as you know, we have made up to 85 tons in weight.

"Yours faithfully, THE BRIGHTSIDE FOUNDRY & ENGINEERING CO., LD."

PRICES OF METALS.

The following table shows the approximate latest prices and position of stocks of metals during the past two years :—

METALS.	1906-7.	1905-6.
Iron—Scotch pig warrants ... ton	*59 6	*65 0
—Middlesbro' warrants ... ... ton	49 4	61 0
—W.C. M/nos Bessemer ... ... ton	£8 6	74 0
—Stock, Scotch, Dec. 3 ... tons	1,224	9,380
Copper—Chili bars, GMB ... ... ton	£60 17 6	£101 12 6
—Stock, Europe & afloat... ... tons	15,789	14,243
Tin—English ingots ton	£137 10 0	£198 10 0
—Straits ... ton	£133 15 0	£195 5 0
—Stock, Ldn. Hlnd and afloat ... tons	12,664	12,825
Lead—English pig ton	£15 5 0	£19 16 3
Spelter—Ord. Silesian ... ... ton	£21 2 6	£28 2 6
Quicksilver (75lb.) bottle	£8 4 6	£7 0 0
Antimony—Regulus ... ... ton	£32-£36	£115 0 0

*Settlement price.

CASTINGS.

In the Cleveland district the following are the nominal rates current for castings :—

	£ s. d.		£ s. d.
Columns (plain)	7 0 0	to	7 5 0
Pipes, 1½ to 2½ in.	5 7 6	to	5 12 6
,, 3 to 4 in....	5 0 0	to	5 7 6
,, 5 to 8 in.	4 17 6	to	5 2 6
,, 10 to 16 in....	4 17 6	to	5 2 6
,, 18 to 24 in....	4 17 6	to	5 2 6
Chairs	3 17 6	to	4 0 0
Floor plates (open sand)	3 0 0	to	3 2 6

SCRAP.

The quotations for scrap, subject to market fluctuations, are as follows:—Heavy wrought (mixed), £2 14s. 0d.; light wrought, £1 15s. 0d.; heavy cast, £2 7s. 6d.; all per ton f.o.b., London. Copper (clean), £55 10s. 0d.; brass (clean), £53 10s. 0d.; lead (usual draft), £14 5s. 0d.; tea lead, £ —— ; zinc, £16 0s. 0d.; all per ton delivered merchant's yard.

SILICA FIRE BRICK Co.,

OUGHTIBRIDGE.

GROUND GANISTER,

Wet or Dry.

Silco Cupola Bricks, 90 % Silica.

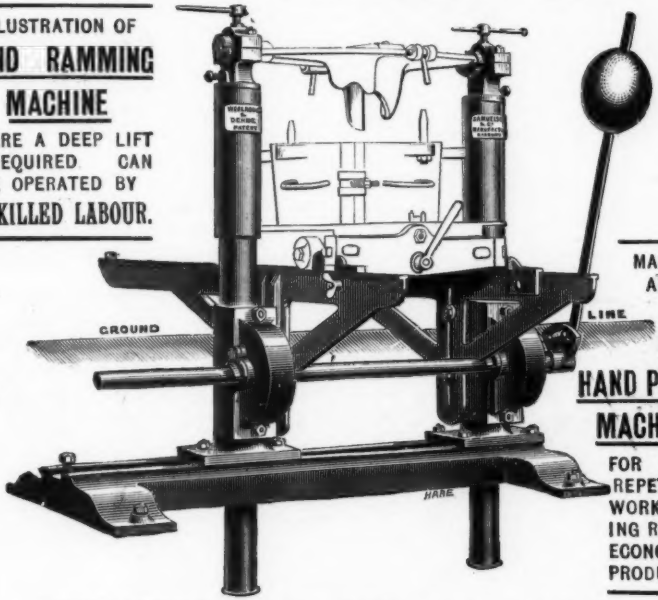
Better than Fire-clay Bricks for Cupolas.

IMPORTANT TO IRONFOUNDERS

MOULDING MACHINES

FOR REPETITION FOUNDRY WORK.

ILLUSTRATION OF
HAND RAMMING MACHINE
WHERE A DEEP LIFT IS REQUIRED CAN BE OPERATED BY
UNSKILLED LABOUR.



MAKERS ALSO OF A
NEW HAND PRESS MACHINE
FOR SMALL REPETITION WORK, GIVING RAPID & ECONOMICAL PRODUCTION

MOST EFFICIENT and ECONOMICAL IN USE.

ALSO MAKERS OF **ROOTS' "ACME" BLOWERS**

FULL PARTICULARS FROM—

SAMUELSON & CO., LTD., BANBURY,
ENGLAND.

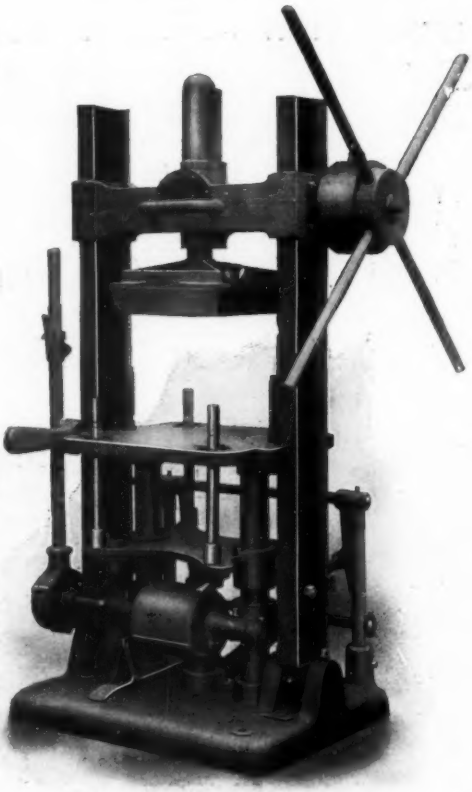
SEE OUR ADVERTISEMENT EVERY ALTERNATE MONTH.

2

THE "COVENTRY"

MOULDING MACHINE.

(By Royal Letters Patent.)



A Power Machine

without Power.

MADE BY

THE BRITANNIA FOUNDRY CO.,

COVENTRY, England.

SITUATIONS VACANT.

FOUNDRY MANAGER, with 16 years' experience, desires engagement; practical mechanic. Good references, moderate salary.—MARTIN, 7, Hilda Road, Brixton, S.W.

WANTED, in Provincial Foundry, FOREMAN MOULDER, capable of economically producing light Iron and Brass Castings, of the very highest quality; knowledge of malleable advantageous. Applications only from really competent men, with first-rate credentials, will be considered.—Address Box 605, Offices of THE FOUNDRY TRADE JOURNAL, 165, Strand, London, W.C.

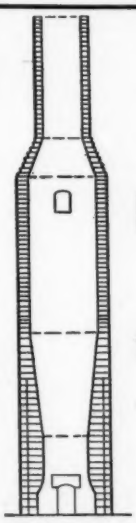
STOREKEEPER Wanted, 6 o'clock man, used to storing and keeping accurate inwards and outwards accounts of small castings on the card system. Preference would be given to man used to brass cocks, valves, and steam fittings generally. He would also be required to receive and issue scrap metals to Foundry, and keep Foundry accounts generally, under supervision of office.—Apply, stating previous experience, present and past employers, age, and wages required, to Box No. 606, Offices of THE FOUNDRY TRADE JOURNAL," 165, Strand, London, W.C.

FOR SALE AND WANTED.

FOR SALE, FOUNDRY, up to date, with house, plant, shops and tools complete. Owner retiring. — Address BREHAUT, St. Sampsons, Guernsey.

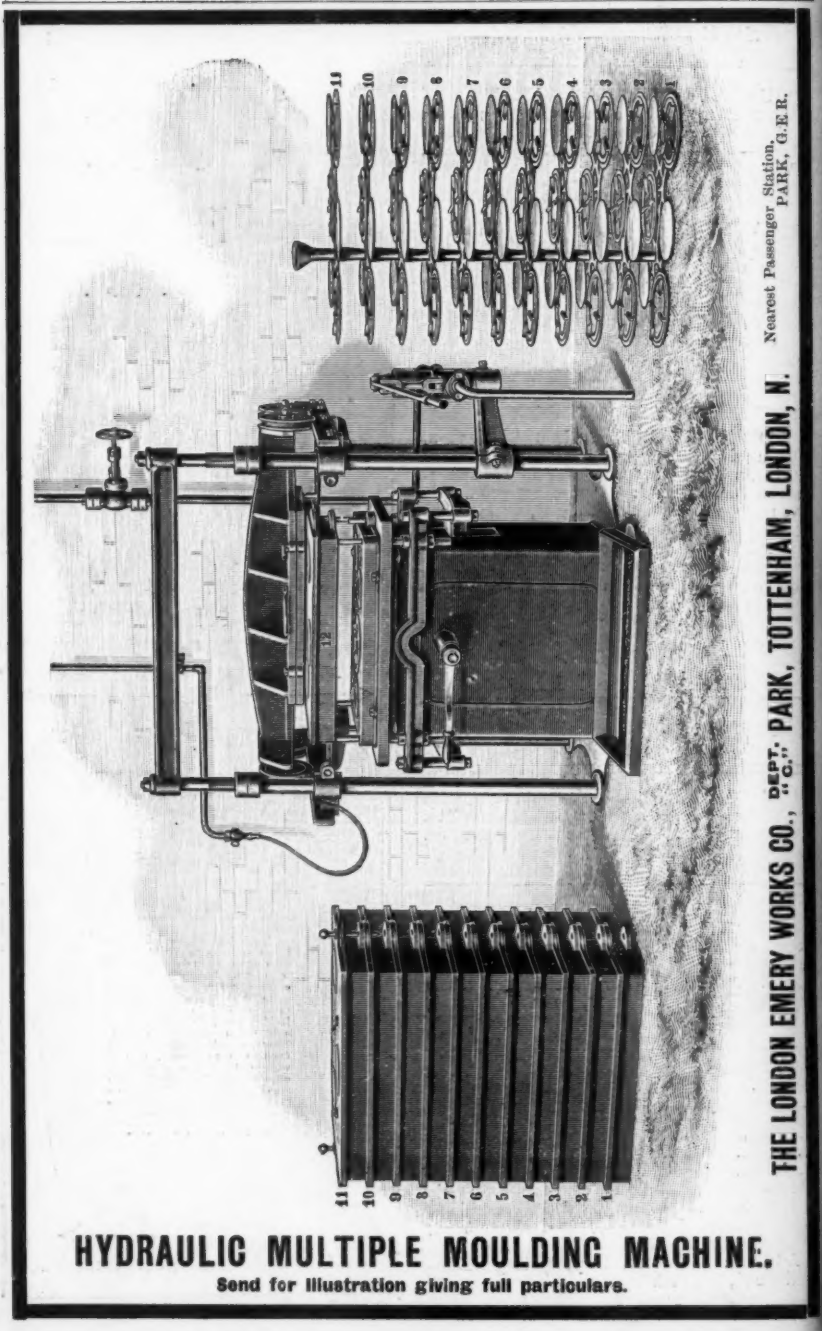
FOUNDRIES, one within 30 miles of London and the other in Scotland, with extensive and substantial Buildings, partly equipped with Plant, to be SOLD by PRIVATE TREATY.—For details and terms apply to FULLER, HORSEY, SONS & CASSELL, 11, Billiter Square, E.C.

FOR SALE, PATENT PRESSURE BLOWERS FOR CUPOLAS:—
No. 1a size "Allday's" 6 in. outlet, as new.
" 5a " "Thwaite's" 4 in. " "
" 2 " " 8 in. "
" 13 " "Baker's" 11½ in. "
Air Compressor Belt, Driven, for Pneumatic Tools, Sand Blasting, Moulding Machines, etc. Size 8½ in. by 7½ in., about 55 ft. free air per minute.
Address: J. LIGHT, Hope Cottage, Dunstall Road, Wolverhampton.



Special . .
Quality . .
FIREBRICKS
. for .
CUPOLA
LININGS.
GEORGE K. HARRISON, Ltd.
Fireclay Brick Works,
STOURBRIDGE.

38½"
McNEIL'S
PATENT UNBREAKABLE
STEEL LADLES
These Ladles are manufactured by a patented process, each from a single steel plate without weld or rivet. They are extremely light, being at the same time the strongest and most durable in the market. Ladles to contain 56 lb. of metal only weigh about 7 lb. each. They are made of all capacities from 30 lb. to 60 cwt., with or without lips; also mounted or unmounted. They are also suitable for chemical and metallurgical processes. List of sections and prices on application
CHAS. McNEIL.
KINNING PARK IRONWORKS,
GLASGOW.
23½"
Can also be made in Aluminium.



THE LONDON EMERY WORKS CO., DEPT. "C." PARK, TOTTENHAM, LONDON, N.

Nearest Passenger Station, PARK, G.E.R.

HYDRAULIC MULTIPLE MOULDING MACHINE.

Send for Illustration giving full particulars.